TESTIMONY OF
LEWIS HAY, III

BEFORE THE
SENATE COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS

"EXAMINING GLOBAL WARMING ISSUES IN THE POWER PLANT SECTOR"

Thursday, June 28, 2007

Madam Chairman, Members of the Committee, thank you for the opportunity to be here today. My name is Lew Hay, and I am the Chairman and CEO of FPL Group, the holding company for Florida Power & Light Company and FPL Energy. Through Florida Power & Light, we provide electricity service to roughly half the state of Florida, the fourth largest state in the nation, or over eight million people. Through FPL Energy we operate in competitive generation markets in roughly half the states outside of Florida. Together, these businesses operate a fleet of over 35,000 megawatts of capacity, making us one of the top four generators in the country. Our generation fleet is one of the cleanest in the country and among the lowest emitters of carbon dioxide. FPL Energy is by far the largest wind energy producer in the country. We own and operate approximately one-third of all the wind capacity in the country, and our capacity exceeds that of the next eight largest players combined. No company anywhere on the globe has developed and built more wind capacity than we have. We are also the largest solar energy producer in this country and the operator of the two largest solar fields in the world. And we have experience with a number of other forms of renewable energy production. Thus, I think we can fairly claim to know a bit about renewable energy.

We also know a bit about conservation and energy efficiency. In Florida, with the support and leadership of the Florida Public Service Commission, we have been actively engaged with conservation and demand side management programs for over 25 years. In fact, according to the Department of Energy statistics, Florida Power & Light is first in the nation in energy conservation programs among electric utilities. Energy efficiency is not something that has just occurred to us recently as the right thing to do. Over the years, our demand side management programs have enabled us to avoid building the equivalent of eleven major power plants and thus to avoid all the emissions that would otherwise have resulted. We have calculated that if the rest of the industry had conservation efforts roughly as effective as ours it would be as though the single largest emitter of CO_2 in the U.S. electric utility sector did not exist from an emissions standpoint. CO_2 emissions would be reduced by about 240 million tons per year, which is equivalent to 9.5% of the emissions of the entire electric utility sector.

We have had a track record of focusing on environmental issues for many years, and it has been an explicit part of our strategy to seek to build into our future expectations our view of where future environmental constraints will take us. We have sought to look ahead and anticipate rather than to wait and react. Because of our past actions, our emissions profile today is among the best in the industry. To put this in perspective, we have calculated that if the rest of the industry were today operating at our emissions intensity for carbon dioxide – that is emitting the same amount of carbon for every megawatt hour they produced as we do – the U.S. today would be under its Kyoto target for total carbon emissions – even without any contribution from other sectors. And we know we can do better. So can the rest of our industry. But to do better will require the right kind of public policy framework.

We have been able to combine exceptional environmental performance with strong financial performance. For five years in a row we have been named the most sustainable electric utility in the country by Innovest Strategic Value Advisors. We are one of 19 U.S. companies that Corporate Knights rated in the top 100 sustainable companies in the world. And just this year we were named by *Fortune* magazine as the most admired electric utility in that magazine's annual survey of our industry. We are proud of our accomplishments and our track record. However, our environmental performance has not come without a cost and I would be remiss if I did not point that out.

Today, although our retail rates are below industry averages, our customers in Florida clearly pay more for electricity than they would if we had a higher percentage of coal in our fuel mix. Conversely, the customers of many utilities elsewhere in the country are in our view paying prices that are attractively low only because the true cost of their environmental impact is not reflected in those prices. We firmly believe that the single most important step Congress can take is to ensure that as we move forward, the cost of emitting carbon into the atmosphere becomes fully reflected in the market prices of all products and services.

Major corporate carbon emitters, including electric generators, can reduce their carbon footprint by improving their energy productivity, relying more on renewable forms of energy like wind, solar and geothermal, burning cleaner fuels and working with their customers to encourage more conservation and improve their efficiency (e.g., use more efficient air conditioners). But they have little incentive to do so because they are not required to pay for their carbon emissions or global warming's effects.

Turning to the specifics of how to deal with global climate change, we have clear views. I expect they will in some way challenge every member of this Committee. In brief, we believe anthropogenic (man-made) global climate change is real and requires prompt policy attention, but that it is not yet a crisis. We must take action, but the wrong actions can be worse than doing nothing at all. Getting the U.S. economy on a path to lower carbon intensity and ultimately reducing carbon emissions will <u>not</u> be cost free – but if done correctly it does not need to wreck the economy either. The devil is in the details.

To be effective, any program must

- Set a market price on carbon which will be reflected in the price of every good and service throughout the economy;
- Apply throughout the economy, not just for reasons of fairness but more importantly for effectiveness. Carbon is pervasive throughout the economy and programs that focus on just one sector, such as our own, will not effectively address the problem;
- Protect import- and export- sensitive industries, otherwise production will simply flee offshore to locations that do not price carbon into their output; and,
- Recycle the dollars that will be extracted from end consumers through higher prices back into their pockets, or we will do serious damage to the economy.

Our analysis has led us to conclude that the simplest, most effective way to do this is through a carbon fee. As many of you know, this view is shared by numerous others who have analyzed the problem, including most economists. William Pizer, an economist for Resources for the Future and who has studied greenhouse gas controls for more than a decade, concludes that, "I find that price mechanisms produce expected net gains *five times higher* than even the most favorably designed quantity target."[1] Editorials published in *The Economist*[2], the *Los Angeles Times*[2] and *The Washington Post*[2] have all endorsed the use of a fee, as has former Federal Reserve Board Chairman, Alan Greenspan, and former Vice President, Al Gore. A carbon fee is

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[1] Pizer, William, "Choosing Price or Quantity Controls for Greenhouse Gases," Climate Issues Brief No. 17 (Washington, DC: Resources for the Future), July 1999. A copy of this paper is attached.

[2] Copies of these editorials are attached to our written testimony.

administratively simple; it automatically becomes economy-wide; it is easy to recycle to consumers; and, crucially, it provides us in the industry with the price signals we need to make long term capital decisions – the very capital decisions that will ultimately determine whether or not we bring down our national emissions profile over time. We have suggested that the price start out at a modest level – say $10 per ton of CO_2 emitted – and rise predictably each year by, say, $2 per ton.[3]

Many people will tell you that a fee is just a tax, and a tax is politically infeasible. In fact, I'm sure you will hear the old witticism about waterfowl – if it quacks like a duck, etc. That is a good sound bite; but frankly, it's a bit silly. Senators, let me be quite clear – any action you take to constrain carbon will effectively impose a tax on our economy; that is a simple matter of economics. In our view, however, there are important differences between a carbon fee and what most people think of when they think of a tax.

A tax is designed to raise revenue to fund common needs and social services; a carbon fee is designed to change relative prices and to be revenue neutral. Taxes are generally designed to be unavoidable. Companies can avoid paying a carbon fee by not emitting carbon – exactly the behavior we need to encourage. Moreover, if it is effective, in time a carbon fee will be self-extinguishing.

To be effective, a carbon fee must be recycled, and we believe it should be recycled three ways. First, the bulk of the fee should be returned to consumers directly, and the simplest way to do this is through a per capita allowance. Think of it as your personal allowance for your carbon footprint. Each year, every adult would receive a proportionate share in the proceeds of the aggregate fee, economically offsetting the typical emissions profile while preserving the price signal that will discourage the use of carbon intensive products or production methods. Second, some of the fee needs to be reserved to protect those few industries that are genuinely exposed to direct competition from foreign firms that do not have an equivalent cost of carbon embedded in their cost structures. Third, a portion of the fee needs to be reserved for fundamental research into carbon reduction and elimination technologies, such as carbon capture and sequestration, without which in the long run we simply will not address the issue. EPRI estimates that in order to develop technologies necessary to address climate change in the electrical sector alone, RD&D funding will need to increase by roughly $ 1.3 billion per year over the next 25 years – or a total of $ 33 billion. I suspect the actual amount needed will be at least twice that amount. The balance among the three ways for recycling carbon fees back into the economy can be adjusted over time, with the allocations to R&D and industry protection diminishing as the global economy adjusts to a new state.

Finally, critics of a carbon fee will say it is not market based while cap and trade is. This is just not true – both approaches are market based. Under a cap and trade approach, volumes of CO_2 emissions are established and the market establishes a price, while under a carbon fee approach, the price for emitting carbon is established and market forces determine the corresponding volumes of CO_2 emissions. In both cases, market forces determine which specific forms of carbon reduction activities in what proportions are undertaken by private economic actors.

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[3] These values can be adjusted upwards each year for general inflation, in order to maintain the desired level of increasing real burden.

A fee is very different from a tax, but in one way it is similar: It will require real political courage to implement. I believe our government has the courage to address this problem the right way. However, if a fee really is politically infeasible, then the next best alternative is the right type of cap and trade program. But Senators, I must caution you that not all cap-and-trade systems are created equal. In fact, there are tremendous differences across the array of cap and trade proposals that are being discussed. If you pursue cap-and-trade I urge you to become personally involved in understanding the details of how it will work and how it will be administered. This is too important an issue for it to be delegated to an executive agency without considerable guidance from Congress. We support cap-and-trade proposals such as Senator Carper's and Senator Feinstein's, which have sought appropriately to address some of the practical issues of this approach.

Let me give you one simple but critical example of the practical issues you must address in cap-and-trade. Under a cap-and-trade approach, each year a fixed quantity of allowances are created – each allowance representing the right to emit a fixed amount of carbon dioxide or other greenhouse gas. Unless most of, if not all, those allowances are auctioned off, which incidentally is an approach that we endorse, the specific method by which those allowances are allocated across industries and to firms or production sources within those industries becomes very important. Allowances represent a valuable financial asset. We estimate the total value of allowances per year to be between \$70 billion and \$300 billion – or between \$2 trillion and \$9 trillion over the first 30 years of a carbon regulatory program – suggesting that the allocation process will be highly politicized and highly susceptible to rent seeking influence in Washington. The initial stages of the European carbon trading scheme show how significant the allocation question can be. It is widely agreed that allowances were over-allocated in some instances, leading to windfall profits for some market participants, particularly those participants who were the largest emitters of CO_2. Whatever approach is taken, you can be sure that someone will be unhappy, and in our society that is likely to mean litigation, and litigation is likely to slow down the pace at which real emission improvements are actually made.

Consider two different ways of allocating allowances to electric generation sources: In the first, every megawatt hour produced receives the same number of allowances, a so-called output-based approach; while in the second allowances are allocated based on fuel input where every BTU of energy input receives the same number of allowances – a so-called input-based approach. Under the first, every generator has to reach the same goal, or pay the consequences; under the second, every generator has to improve by the same proportional amount, or pay the consequences. The first rewards those who have already moved to become efficient, low emitters, since they will have to buy fewer allowances to reach the common goal; while the second rewards those who have taken no action and who have old, inefficient and, for the most part, fully depreciated plants. As you think about carbon policy proposals, Senators, I urge you to consider this issue. Which would you rather reward: companies that have planned ahead and sought to anticipate policy trends and who have low emissions profiles today? Or firms that have sat back and taken advantage of low cost but high emissions technologies like traditional coal generation? We believe the answer should be obvious – you should not reward the worst emitters. But that is one of the many practical consequences that the exact form of a cap and trade program will have, and it is one that I urge you to think carefully about.[4] I know you will follow your consciences; I hope my testimony will cause you to dig further into these practical issues.

The illustration I have just given you is but one of many practical issues with cap-and-trade. Close study of the problems encountered in the early days of the European carbon trading scheme reveal many others. These problems include:

- How to address differing regional growth rates. Non-updating allowance allocations, such as an input-based allocation based on historical BTU consumption, would impose large penalties on faster growing states, such as California, Arizona, Nevada and Florida.

- How to avoid unnecessary economic damage associated with highly volatile permit prices. Even under the highly praised SO_2 program, the price of SO_2 allowances has varied, on average, by more than 40% per year and has increased over 80% per year over the past three years. Given CO_2's importance to the economy, this could have devastating impacts ranging from higher inflation, reduced consumer spending and reduced investments in green technology.

- How to prevent hoarding of credits and other attempts to manipulate the market.

Each proposed "fix," such as including price floors and ceilings, adds complexity and possibly other unintended consequences, and, in effect, makes a cap and trade system work more and more like a carbon fee, albeit without the benefits that a carbon fee brings such as predictable pricing, fairness and administrative simplicity.

That said, we believe that market-based trading schemes can be made to work, but the right way to implement them is to auction the majority of allowances and give away the remainder for a short transition period. Our analysis has convinced us that it is neither necessary nor desirable to give away for free any large proportion of the total allowances created each year. In most cases, utilities and independent generators will recover the costs of purchasing allowances through charging higher prices. It is the end consumer who will ultimately bear the burden. An auction-based system, with the proceeds of the auction recycled direct to end consumers on a per capita basis, best protects against unintended windfalls for producers. To the extent that there are free allowances, they should be allocated on an output basis (per MWH) (with the possible exclusion of nuclear and renewable generation, which have already received plenty of government support). The proceeds of the auctions should be recycled back into the economy in the same three ways as I have described for a carbon fee. Even then, with a cap-and-trade approach you will face the difficult choice of deciding exactly how tight the caps should be each year. Too loose, and we don't make the progress we could make; too tight and you surely will do serious damage to the economy. Unfortunately, as the Intergovernmental Panel on Climate Change's own reports acknowledge, no one today can tell you what those caps should be, so you will be left to guesswork. This is another reason why we have concluded that a fee-based approach is superior. While there is still some guesswork involved, it is much easier to set a path for the future price of carbon than for the future volume of emissions reductions that will be manageable

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[4] In a recently issued white paper, Clean Air Watch estimates that with an input based approach, the top ten carbon emitting electric utility companies would reap a windfall of a range from at least $4.5 to $9 billion per year (assuming allowance prices ranged from between $5 to $10 per ton).

without major economic damage. And the future price of carbon – a so-called forward price curve – is the most crucial piece of information that all of us in business need to know in order to make the long-term investment decisions without which we will never succeed in bringing down our national emissions profile. If a cap-and-trade approach is used, it is critical that a pre-determined ceiling price, or "safety valve," be included, in order to avoid the threat of significant economic disruption in the event of very volatile allowance pricing.

Senators, I know that there are some who do not believe that the science of climate change is conclusive, or that the consequences are certain. We agree. But we know enough to warrant taking action today. We know enough to know there is risk of severe consequences, and just as we buy insurance or wear seatbelts, we need to address that risk. But just as we don't give up all our income to purchase insurance, we need to be balanced in our approach to addressing that risk. A moderate carbon fee, escalating steadily and predictably, and recycled directly back into the economy, will have only a modest drag on the economy, but it will over time induce massive change in our carbon emissions profile, especially when it is supported by adequate R&D. The same effect can be produced, though with greater complexity and less effectiveness, through a properly designed cap-and-trade system with a high percentage of allowances auctioned and a pre-determined safety valve built in. But a poorly designed scheme, or one that does not force a price on carbon throughout the economy, will not address the real environmental issue, and it will risk major economic dislocation.

Thank you for the opportunity to contribute to this critical public dialog.

Attachments:

"Doffing the Cap," The Economist, June 14, 2007.

Eilperin, Juliet and Mufson, Steven. "Tax on Carbon Emissions Gains Support; Industry and Experts Promote It as Alternative to Help Curb Greenhouse Gases," The Washington Post, April 1, 2007.

Green, Kenneth P., Hayward, Steven F., and Hassett, Kevin A. "Climate Change: Caps vs. Taxes," Environmental Policy Outlook No. 2. Washington, DC: American Enterprise Institute for Public Policy Research, June 2007.

"Time to Tax Carbon: A Carbon Tax is the Best, Cheapest and Most Efficient Way to Combat Cataclysmic Climate Change," Los Angeles Times, May 28, 2007.

Pizer, William, "Choosing Price or Quantity Controls for Greenhouse Gases," Climate Issues Brief No. 17, Washington, DC: Resources for the Future, July 1999.

"Should Big Polluters Own the Sky?," Clean Air Watch, June 2007

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Doffing the cap

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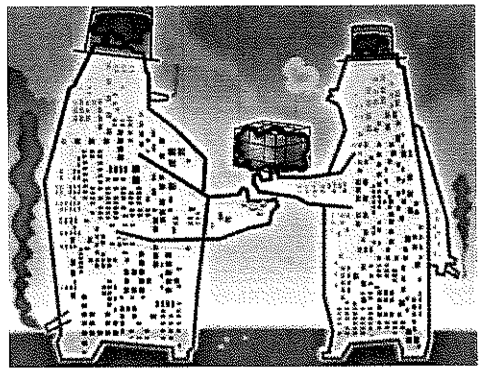

Tradable emissions permits are a popular, but inferior, way to tackle global warming

THE pressure for political action on climate change has never looked stronger. Even George Bush has now joined the leaders of other rich countries in their quest to negotiate a successor regime to the Kyoto protocol, the treaty on curbing greenhouse gases that expires in 2012.

Too bad, then, that politicians seem set on a second-best route to a greener world. That is the path of cap-and-trade, where the quantity of emissions is limited (the cap) and the right to emit is distributed through a system of tradable permits. The original Kyoto treaty set up such a mechanism and its signatories are keen to expand it. The main market-based alternative—a carbon tax—has virtually no political support.

A pity, because most economists agree that carbon taxes are a better way to reduce greenhouse gases than cap-and-trade schemes. That is because taxes deal more efficiently than do permits with the uncertainty surrounding carbon control. In the neat world of economic theory, carbon reduction makes sense until the marginal cost of cutting carbon emissions is equal to the marginal benefit of cutting carbon emissions. If policymakers knew the exact shape of these cost and benefit curves, it would matter little whether they reached this optimal level by targeting the quantity of emissions (through a cap) or setting the price (through a tax).

But in the real world, politicians are fumbling in the dark. And that fumbling favours a tax. If policymakers set a carbon tax too low, too much carbon will be emitted. But since the environmental effect of greenhouse gases builds up over time, a temporary excess will make little difference to the overall path of global warming. Before much damage is done to the environment, the carbon tax can be raised.

Misjudging the number of permits, in contrast, could send permit prices either skywards or through the floor, with immediate, and costly, economic consequences. Worse, a fixed allotment of permits makes no adjustment for the business cycle (firms produce and pollute less during a recession).

Cap-and-trade schemes cause unnecessary economic damage because the price of permits can be volatile. Both big cap-and-trade schemes in existence today—Europe's Emissions-Trading Scheme for carbon and America's market for trading sulphur-dioxide permits (to reduce acid rain)— suggest this volatility can be acute. America has had tradable permits for SO_2 since the mid-1990s. Their price has varied, on average, by more than 40% a year. Given carbon's importance in the economy, similar fluctuations could significantly affect everything from inflation to consumer spending. Extreme price volatility might also deter people from investing in green technology.

Even without the volatility, some economists reckon that a cap-and-trade system produces fewer incentives than a carbon tax for climate-friendly innovation. A tax provides a clear price floor for carbon and hence a minimum return for any innovation. Under a cap-and-trade system, in contrast, an invention that reduced the cost of cutting carbon emissions could itself push down the price of permits, reducing investors' returns.

To avoid these pitfalls, some cap-and-trade advocates want to set price floors and ceilings within carbon-trading systems. One of the most prominent bills in America's Congress, for instance, includes a "safety valve". If the price of carbon rises beyond a threshold, the government will allocate an unlimited supply of permits at that price. Such reforms, in effect, make a cap-and-trade system work more like a carbon tax.

A third advantage of carbon taxes is that they raise revenue. Governments can use this cash to reduce other inefficient taxes, thereby cutting the economic costs of carbon abatement. Or they can use the money to compensate those, such as the poor, who are hit disproportionately hard by higher fuel costs.

The great green giveaway

Cap-and-trade schemes, in contrast, have traditionally given away permits, which leaves no room to reduce the economic costs of climate control by cutting taxes elsewhere. But here, too, change may be afoot. To mimic the advantage of a carbon tax, many cap-and-trade fans now want governments to auction at least a share of the permits.

All of which raises an important question. If cap-and-trade schemes are to be reformed so that they look more like carbon taxes, why are politicians so reluctant to impose carbon taxes in the first place? One reason is that their environmental benefits are harder to explain. It is intuitively easier to grasp how a carbon cap will slow global warming. Taxes are also more prone to ideological caricature, particularly in America, where many conservatives argue instinctively that all taxes are bad. Too many politicians pretend that carbon taxes will hurt consumers more than a cap-and-trade scheme, even though the cost of carbon permits will be passed on to consumers just as quickly as a tax.

But the biggest problem, at least politically, is that carbon taxes are transparent and simple, whereas cap-and-trade systems are complicated and conveniently opaque. Under a cap-and-trade scheme, governments can pay off politically powerful polluters (such as the coal industry) by giving them permits. Even more important, rich countries can pay poorer ones to cut their emissions without any cash changing hands between governments. Under a carbon tax such transfers must go through the government's budget. And that can be politically tricky. However sensible it sounds to an economist, American voters may be loth to see their tax dollars funding fat cheques for China. Add in these political arguments and the choice between a carbon tax and cap-and-trade becomes less obvious. Politicians are heading down the second-best path to combat climate change, but it may be the only one that leads anywhere.

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The Washington Post

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Suburban Edition

Tax on Carbon Emissions Gains Support; Industry and Experts Promote It as Alternative to Help Curb Greenhouse Gases

BYLINE: Juliet Eilperin and Steven Mufson; Washington Post Staff Writers

As lawmakers on Capitol Hill push for a cap-and-trade system to rein in the nation's greenhouse gas emissions, an unlikely alternative has emerged from an ideologically diverse group of economists and industry leaders: a carbon tax.

Most legislators view advocating any tax increase as tantamount to political suicide. But a coalition of academics and polluters now argues that a simple tax on each ton of emissions would offer a more efficient and less bureaucratic way of curbing carbon dioxide buildup, which scientists have linked to climate change.

"We want to do the least damage to the growth of GDP," said Michael Canes, a private consultant and former chief economist for the American Petroleum Institute, who led a Capitol Hill briefing on the subject in late February sponsored by the conservative George C. Marshall Institute. Between a cap system and a carbon tax, "a carbon tax will be the much more cost-effective way to go," he said, though he added that there are other ways to reduce emissions.

Robert J. Shapiro, a private consultant who was a Commerce Department official in the Clinton administration, agrees. A cap-and-trade system -- involving plant-by plant-measurements -- would be difficult to administer, he said, and would provide "incentives for cheating and evasion." And the revenue from a carbon tax could be used to reduce the deficit or finance offsetting cuts in payroll taxes or the alternative minimum tax.

A carbon tax offers certainty about the price of polluting, which appeals to many economists and businesses. William A. Pizer, a senior fellow at the centrist think tank Resources for the Future and a former senior economist for President Bush's Council of Economic Advisers, estimates that the benefit-to-cost ratio of a tax-based system would be five times that of a cap-and-trade system.

"You're going to pay one way or another, whether it's a tax or a permit program," Pizer said, adding that while a cap would provide more certainty on how much emissions would be cut, "the consequences of being uncertain about emissions over any short period of time just aren't that serious."

Under a cap-and-trade system, the government would set an overall limit on emissions and allocate permits to emitters. If one plant reduces its emissions more quickly than another, it can sell its credits to the other emitter. A carbon tax would simply increase the cost of emitting each ton of carbon, which could then be passed on to consumers.

While Democrats have vowed to push through some sort of carbon dioxide control in this Congress, Bush has consistently opposed mandatory limits, so it remains unclear whether the United States will adopt any system before the next election.

Moreover, the fact that many economists back the tax approach is no guarantee that it will prevail over the five cap-and-trade plans already proposed in the Senate.

The complexity of the cap-and-trade system is part of its virtue for some politicians, since it may mask the system's impact on prices. Such a system also appeals to conservative lawmakers who like the idea of letting the market determine the price of carbon, while keeping revenue out of the hands of government. Some economists say it would channel capital to the most economically worthwhile projects first.

Environmentalists are split on a carbon tax. Fred Krupp, president of Environmental Defense, which is handing out baseball caps emblazoned with the slogan "Just Cap It" on Capitol Hill, called such a tax "an interesting distraction."

"It doesn't give us the guarantee the emissions will go down," he said.

But Carl Pope, executive director of the Sierra Club, said: "It will be more effective if people know that in year 'X' they will pay this much. Companies are highly motivated by costs." Moreover, he worries that rationing carbon allowances based on historical emissions would reward companies that spew out the most greenhouse gases now and did the least to limit them in the past.

Dan Becker, director of the Sierra Club's program on global warming, said the nation may need to adopt a carbon tax in several years but "we're not there yet."

Some industries that have historically opposed carbon limits embrace the idea of a tax because their sectors would not be singled out for regulation. "A poorly constructed cap-and-trade system can be as punitive as a regressive tax," said Scott Segal, an electric utilities lobbyist.

Red Cavaney, president of the American Petroleum Institute, told a National Press Club audience in February that his industry prefers that lawmakers explore a range of policy options before imposing a cap.

"A cap-and-trade system isn't necessarily the be-all and end-all," he said. "A carbon tax, everything, should be on the table from the beginning."

Few lawmakers, Democrat or Republican, have the stomach for a carbon tax, however. Some are still smarting from a vote in the early 1990s when President Bill Clinton persuaded the House to adopt a BTU tax -- a tax on the heat content of fuels -- only to abandon the effort in the Senate.

Democrats such as House Natural Resources Committee Chairman Nick J. Rahall II (W.Va.) say they have no desire to revisit the issue. "I'm not an advocate of a carbon tax," Rahall said. "That's going to be passed on; the consumer would end up paying for that."

Some analysts said former vice president Al Gore's endorsement of both alternatives in testimony before Congress last week was so politically unpalatable that it was a sign that he is not seriously thinking of running for president.

Only one House Democrat, Rep. Pete Stark (Calif.), has drafted a carbon tax proposal. Stark, who first proposed such a tax 16 years ago as a way to ease the nation's energy crunch, plans to introduce a bill in April that would levy a tax of $25 per ton of carbon released for five years.

"It's more efficient, more equitable, and it's less subject to gaming, I might add," Stark said, estimating that it would raise the cost of gasoline by 10 cents a gallon.

As Congress debates how to regulate greenhouse gases, however, several European officials have said it would be a mistake to choose anything but a market-based trading system that could be linked to the emerging carbon market in Europe.

"Political leaders in the United States need to make a decision, and make it quickly, whether they want to be left behind in a market that is going to evolve, or whether they want to get involved quickly," said Stephen Byers, a member of Britain's Parliament who helped establish the European Union's trading system. "Wall Street could become the world center of carbon trading."

And Stavros Dimas, the E.U. environment commissioner, speaking at a recent lunch hosted by the D.C.-based European Institute, called it ironic that the United States would question the cap-and-trade system, because U.S. negotiators essentially forced Europe to agree to such a system in the Kyoto Protocol negotiations in 1997.

"There was suspicion about market-based instruments," Dimas said. "In a way you did us a favor, because now we also are familiar with these market-based activities. It's functioning very well, actually."

"If we would go together into a world tax regime, that would be preferable," Jos Delbeke, the top E.U. official on climate change, said after a Senate Energy and Natural Resources Committee hearing Monday. "But practically speaking, it is not a likely way to go. Emissions trading is a very solid second best."

American Enterprise Institute for Public Policy Research

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Environmental Policy Outlook

Climate Change: Caps vs. Taxes

By Kenneth P. Green, Steven F. Hayward, and Kevin A. Hassett

As the Kyoto Protocol's 2012 expiration date draws near, a general theme dominates the global conversation: leadership and participation by the United States are critical to the success of whatever climate policy regime succeeds the Kyoto Protocol. Two general policy approaches stand out in the current discussion. The first is national and international greenhouse gas (GHG) emissions trading, often referred to as "cap-and-trade." Cap-and-trade is the most popular idea at present, with several bills circulating in Congress to begin a cap-and-trade program of some kind. The second idea is a program of carbon-centered tax reform—for example, the imposition of an excise tax based on the carbon emissions of energy sources (such as coal, oil, and gasoline), offset by reductions in other taxes. In this paper we will address the strengths and weaknesses of both ideas and the framework by which legislators should evaluate them.

The framing of a global climate regime presents a classic chicken-and-egg problem: the United States does not wish to enter into a regime of economically costly emission caps or taxes that would have the effect of driving industry and jobs to nations such as China and India that do not participate in such caps. China and India, however, are unlikely to enter into a restrictive regime unless the United States goes first, and even then, only so long as the policy regime does not threaten serious constriction of their economies. It is often assumed that if the United States goes first, developing nations will eventually follow, but this is by no means assured. Both China and India have repeatedly declared that they are not prepared to make even a delayed commitment at this time.

Given these policy uncertainties—and other uncertainties about the eventual impacts of climate change in terms of severity, distribution, and timing—there are two guideposts policymakers should keep in mind. The first is that the United States can only effectively impose a national regulatory regime (though such a regime could eventually be harmonized with international efforts). The second is that, given the current uncertainty, policy should conform as much as possible to a "no regrets" principle by which actions undertaken can be justified separately from their GHG emissions effects in the fullness of time, such that nonparticipation by developing nations will disadvantage the United States in the global marketplace as little as possible.

While the United States may wish to join with other nations in setting a post-Kyoto emissions goal, it should be wary of joining an international emissions-trading or other regulatory regime. One of the less-remarked-upon aspects of the Kyoto Protocol, and any prospective successor treaty on that same model, is that it represents an unprecedented kind of treaty obligation for the United States. Most treaties involve direct actions and policies of governments themselves, such as trade treaties that bind nations' tariff levels and affect the private sector of the economy only indirectly. Kyoto and its kin go beyond government policy to affect the private sector directly or require the

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government to control the private sector and the investment decisions of the private sector to an unprecedented degree. It is not governments that emit GHGs, after all. Between the asymmetries of legal and regulatory regimes across nations, the United States should think hard about the dilution of sovereignty that a binding GHG treaty represents, even if the United States agrees with the basic objective of reducing carbon emissions.

Problems with Emissions Trading for GHG

Some economists favor the idea of emissions trading for its elegance in achieving least-cost emissions reductions while avoiding the manifold difficulties of prescriptive "command-and-control" regulation from a centralized bureaucracy. But this is something of a false choice, as such regulation is a deeply troubled policy option. While trading may be superior to command-and-control, it is not necessarily superior to other alternatives, such as carbon-centered tax reform.

There are a number of emissions-trading success stories that, upon inspection, suggest significant limitations to the applicability of emissions trading for GHG emissions. Enthusiasts for cap-and-trade point first to our sulfur dioxide (SO_2) trading experience under the 1990 Clean Air Act Amendments. It is claimed that the costs of SO_2 abatement through trading turned out to be dramatically lower than economists had forecast for a prescriptive regime, wherein the Environmental Protection Agency (EPA) would have mandated control technologies on individual coal-fired power plants. But a closer look shows this success to have been uneven. There has been significant volatility in emission permit prices, ranging from a low of $66 per ton in 1997 to $860 per ton in 2006, as the overall emissions cap has been tightened, with the price moving up and down as much as 43 percent in a year.[1] Over the last three years, SO_2 permit prices have risen 80 percent a year, despite the EPA's authority to auction additional permits as a "safety valve" to smooth out this severe price volatility.

Several other aspects of the SO_2-trading program are of doubtful applicability to GHGs. First, SO_2 trading was only applied to a single sector: initially, only 110 coal-fired power plants were included in the system, but it subsequently expanded to 445 plants. While coal-fired power plants account for roughly one third of U.S. carbon dioxide (CO_2) emissions and will therefore be central to a GHG cap-and-trade program, a comprehensive GHG emissions-trading program will have to apply across many sectors beyond electric utilities, vastly complicating a trading system.

Second, SO_2 and CO_2 are not comparable targets for emissions reduction. Reducing SO_2 emissions did not require any constraint on end-use energy production or consumption. Coal-fired power plants had many low-cost options to reduce SO_2 emissions without reducing electricity production. Some switched to low-sulfur coal (abetted in large part by railroad deregulation in the 1980s, which made transport of Western low-sulfur coal more economical than previously). The cost of "scrubbers"—industrial devices which capture SO_2 and sequester it—turned out to be lower than predicted. Other utilities emphasized more use of natural gas. The impact on ratepayers and consumers was modest.

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CO_2 is different: it is the product of complete fuel combustion. There is no "low-CO_2 coal," and the equivalent of SO_2 scrubbers does not yet exist in economical form.[2] At the margin there is some opportunity for GHG emissions reductions through substitution—increased use of natural gas (which emits less CO_2 per unit of energy than coal) and possibly nuclear power—but the inescapable fact is that any serious reduction in CO_2 emissions will require a suppression of fuel combustion. This is going to mean lower energy consumption and higher prices, at least in the intermediate term.

Even though confined to a segment of a single sector of energy use, the SO_2 emissions-trading regime was far from simple. There were complicated allocation formulas to distribute the initial emissions permits. Despite the best efforts to create objective criteria, at the end of the day, the allocation of emission permits involves some arbitrary discretion. For political reasons there were special subsidies and extra allowances for the benefit of high-sulfur coal interests. Most trading in the early years took place between power plants within the same company.

Establishing allowances and accounting systems for GHG emissions across industries is going to be vastly more difficult and highly politicized. The forest products industry, for example, will reasonably want credits for creating carbon sinks in the trees it plants and harvests, but the manufacturing sector that uses these wood products as a raw material will want credit for sequestering carbon. The difference will have to be split in some arbitrary manner that will surely introduce economic distortions in the marketplace. The auto industry will want credits for GHG innovations, while industries and businesses of all kinds will lobby for credits for reducing mobile source emissions from changes to their auto and truck fleets. There are going to be winners and losers in this allocation process. Multiply this problem across sectors and industries and it becomes evident that a GHG emissions-trading system is going to be highly complex and unwieldy, and too susceptible to rent-seeking influence in Washington. The problem of politically adjusting competing interests will be compounded on the international scale. The long-running diplomatic conflicts that can be observed over purported subsidies for aircraft (i.e., Boeing versus Airbus) and the European Union's agricultural subsidies and trade barriers are examples of the kinds of conflicts that will be endemic to any international emissions-trading scheme.

The favored solution to these problems is to over-allocate the number of initial permits both to ease the cost and to encourage the rapid start-up of a market for trades. This was the course the European Union took with its Emissions Trading System (ETS), and it has very nearly led to the collapse of the system. Because emissions permits were over-allocated, the price of emissions permits plummeted, and little—if any—emissions reductions have taken place because of the ETS. The over-allocation of initial permits merely postpones both emissions cuts and the economic pain involved. Economist Robert J. Shapiro notes:

> As a result of all of these factors and deficiencies, the ETS is failing to reduce European CO_2 emissions. . . . [T]he European Environmental Agency has projected that the EU is likely to achieve no more than one-quarter of its Kyoto-targeted reductions by 2012, and much of those "reductions" will simply reflect credits purchased from Russia or non-Annex-I countries [developing countries], with no net environmental benefits.[3]

As economist William Nordhaus observes:

> We have preliminary indications that European trading prices for CO_2 are highly volatile, fluctuating in a band and [changing] +/- 50 percent over the last year. More extensive evidence comes from the history of the U.S. sulfur-emissions trading program. SO_2 trading prices have varied from a low of \$70 per ton in 1996 to \$1500 per ton in late 2005. SO_2 allowances have a monthly volatility of 10 percent and an annual volatility of 43 percent over the last decade.[4]

Nordhaus points out the ramifications of such volatility, observing that "[s]uch rapid fluctuations would be extremely undesirable, particularly for an input (carbon) whose aggregate costs might be as great as petroleum in the coming decades," and that "experience suggests that a regime of strict quantity limits might become extremely unpopular with market participants and economic policymakers if carbon price variability caused significant changes in inflation rates, energy prices, and import and export values."[5]

Nordhaus is not alone in this concern about price volatility. Shapiro similarly observes:

> Under a cap-and-trade program strict enough to affect climate change, this increased volatility in all energy prices will affect business investment and consumption, especially in major CO_2 producing economies such as the United States, Germany, Britain, China and other major developing countries.[6]

Additional pitfalls and dilemmas of emissions trading can be seen through a review of the spectacular trading failure of the RECLAIM (Regional Clean Air Incentives Market) emissions-trading program in Southern California. Launched in 1994 after three years of development, RECLAIM set in motion an emissions-trading program targeting SO_2 and nitrogen oxides (NO_x) emissions, and eventually hoped to expand to include volatile organic compound (VOC) emissions. All three types of emissions are important precursors to ozone formation in the greater Los Angeles air basin. RECLAIM, for the first time, offered swaps between stationary and mobile sources: stationary sources such as oil refineries could help reach their emissions reduction targets by purchasing old, high-polluting automobiles and trucks and taking them off the road—a cost-effective measure in a voluntary demonstration program. The South Coast Air Quality Management District (SCAQMD) estimated that SO_2 and NO_x would be reduced by fourteen and eighty tons per day, respectively, by the year 2003, at half the cost of the usual prescriptive method of regulation.[7] There was great public support and enthusiasm for the program at the outset.

RECLAIM never came close to operating as predicted, and was substantially abandoned in 2001. Between 1994 and 1999, NO_x levels fell only 3 percent, compared to a 13 percent reduction in the five-year period before RECLAIM. There was extreme price volatility aggravated by California's electricity crisis of 2000. NO_x permit prices ranged from $1,000 to $4,000 per ton between 1994 and 1999, but soared to an average price of $45,000 per ton in 2000, with some individual trades over $100,000 per ton. Such high prices were not sustainable, and SCAQMD removed electric utilities from RECLAIM in 2001. SCAQMD also dropped its plan to expand RECLAIM to VOCs. Despite the hope that RECLAIM would be simple and transparent, there were serious allegations of fraud and market manipulation, followed by the inevitable lawsuits and criminal investigations.

One particular problem with RECLAIM that is likely to plague any international GHG emissions-trading regime is the lack of definite property rights to the emissions allowances the program creates. A cliché of the moment is that industry would like some clarity and certainty about any prospective GHG regulatory regime. A cap-and-trade program, however, cannot provide certainty precisely because emissions allowances are not accorded real property rights by law.[8] The government can change the rules at any time, making emissions allowances worthless. This is exactly what happened to electric utilities in Los Angeles: their allowances were terminated, and the utilities were subsequently required to install specified emissions-control technologies and to pay fines for excess emissions. In effect, some Los Angeles firms had to pay three times over for emissions reductions.

A GHG emissions-trading scheme on an international level will be even more vulnerable to these kinds of unpredictable outcomes. To the extent that a GHG emissions-trading program results in international cross-subsidization of the economies of trading partners, it is going to be politically unsustainable in the long run. An international emissions-trading program is also unlikely to survive noncompliance by some of its members.

There are two final, overriding reasons to be doubtful about global emissions trading. It is possible that the defects of previous emissions-trading programs could be overcome with more careful design and extended to an international level, though this would require an extraordinary feat of diplomacy and substantial refinements of international law. Even if such improvement could be accomplished, it would not provide assurance against the prospect that the cost of such a system might erode the competitiveness of the U.S. economy against developing nations that do not join the system.

The second reason for skepticism about global emissions trading is that it fails the "no regrets" test. It is considered bad form nowadays to express doubt or skepticism about the scientific case for rapid and dangerous global warming in the twenty-first century. If warming is either less pronounced than some current forecasts predict or if emissions reductions have limited effect in moderating future temperature rise, however, a severe global emissions-reduction policy through emissions trading (on the order of a minimum 50 percent cut by 2050) could turn out to be the costliest public policy mistake in human history, with the costs vastly exceeding the benefits.

If warming is either less pronounced than some current forecasts predict or if emissions reductions have limited effect in moderating future temperature rise . . . a severe global emissions-reduction policy through emissions trading could turn out to be the costliest public policy mistake in human history, with the costs vastly exceeding the benefits.

Could instituting a tax on the carbon emissions released by fuel use, as part of a revenue-neutral tax reform package, pass these two tests? We believe it could.

Advantages of a Revenue-Neutral, Carbon-Centered Tax Reform

Most economists believe a carbon tax (a tax on the quantity of CO_2 emitted when using energy) would be a superior policy alternative to an emissions-trading regime. In fact, the irony is that there is a broad consensus in favor of a carbon tax everywhere except on Capitol Hill, where the "T word" is anathema. Former vice president Al Gore supports the concept, as does James Connaughton, head of the White House Council on

Environmental Quality during the George W. Bush administration. Lester Brown of the Earth Policy Institute supports such an initiative, but so does Paul Anderson, the CEO of Duke Energy. Crossing the two disciplines most relevant to the discussion of climate policy—science and economics—both NASA scientist James Hansen and Harvard University economist N. Gregory Mankiw give the thumbs up to a carbon tax swap.[9]

There are many reasons for preferring a revenue-neutral carbon tax regime (in which taxes are placed on the carbon emissions of fuel use, with revenues used to reduce other taxes) to emissions trading. Among them are:

- **Effectiveness and Efficiency.** A revenue-neutral carbon tax shift is almost certain to reduce GHG emissions efficiently. As economist William Pizer observes, "Specifically, a carbon tax equal to the damage per ton of CO_2 will lead to exactly the right balance between the cost of reducing emissions and the resulting benefits of less global warming."[10] Despite the popular assumption that a cap-and-trade regime is more certain because it is a quantity control rather than a price control, such a scheme only works in very limited circumstances that do not apply to GHG control. The great potential for fraud attendant on such a system creates significant doubt about its effectiveness, as experience has shown in both theory and practice in the gyrations of the European ETS.

  The likelihood of effectiveness also cannot be said for regulations such as increased vehicle fuel economy standards. In fact, such regulations can have perverse effects that actually lead to increased emissions. By making vehicles more efficient, one reduces the cost of a unit of fuel, which would actually stimulate more driving, and, combined with increasing traffic congestion, could lead to an increase in GHG emissions rather than a decrease.

  As Harvard researchers Louis Kaplow and Steven Shavell point out, "The traditional view of economists has been that corrective taxes are superior to direct regulation of harmful externalities when the state's information about control costs is incomplete," which, in the case of carbon emissions reductions, it most definitely is.[11] And when it comes to quantity controls (as a cap-and-trade system would impose), Pizer found that

  > My own analysis of the two approaches [carbon taxes vs. emission trading] indicates that price-based greenhouse gas (GHG) controls are much more desirable than quantity targets, taking into account both the potential long-term damages of climate change, and the costs of GHG control. This can be argued on the basis of both theory and numerical simulations.

  Pizer found, in fact, that a carbon-pricing mechanism would produce expected net gains five times higher than even the best-designed quantity control (i.e., cap-and-trade) regime.[12]

- **Incentive Creation.** Putting a price on the carbon emissions attendant on fuel use would create numerous incentives to reduce the use of carbon-intensive energy. The increased costs of energy would flow through the economy, ultimately giving consumers incentives to reduce their use of electricity, transportation fuels, home heating oil, and so forth. Consumers, motivated by the tax, would have incentives to buy more efficient appliances, to buy and drive more efficient cars, and to better insulate their homes or construct them with more attention to energy conservation. A carbon tax would also create incentives for consumers to demand lower-carbon power sources from their local utilities. A carbon tax, as its cost flowed down the chains of production into consumer products, would lead manufacturers to become more efficient and consumers to economize in consumption. At all levels in the economy, a carbon tax would create a profit niche for environmental entrepreneurs to find ways to deliver lower-carbon energy at competitive prices. Finally, a carbon tax would also serve to level (somewhat) the playing field among solar power, wind power, nuclear power, and carbon-based fuels by internalizing the cost of carbon emission into the price of the various forms of energy.

- **Less Corruption.** Unlike carbon cap-and-trade initiatives, a carbon tax would create little incentive or opportunity for rent-seeking or cheating. As William Nordhaus explains:

  > A price approach gives less room for corruption because it does not create artificial scarcities, monopolies, or rents. There are no permits transferred to countries or leaders of countries, so they cannot be sold abroad for

> wine or guns. . . . In fact, a carbon tax would add absolutely nothing to the instruments that countries have today.[13]

Without the profit potential of amassing tradable carbon permits, industry groups would have less incentive to try to get credits for their favored but noncompetitive energy sources. That is not to say that tax-based approaches are immune from corruption, for they certainly are not. If set too far down the chain of production or set unevenly among energy sources, carbon taxes could well lead to rent-seeking, political favoritism, economic distortions, and so on. Foreign governments might have an incentive to undermine a trading scheme by offering incentives to allow their manufacturers to avoid the cost of carbon trading. A tax on fuels proportionate to their carbon content, levied at the point of first sale, should be less susceptible to corruption, and by delivering revenue to the government rather than to private entities, should create incentives more aligned with the government's objective.

> A carbon tax, as its cost flowed down the chains of production into consumer products, would lead manufacturers to become more efficient and consumers to economize in consumption.

- **Elimination of Superfluous Regulations.** Because a carbon tax would cause carbon emissions to be reduced efficiently across the entire market, other measures that are less efficient—and sometimes even perverse in their impacts—could be eliminated. With the proper federal carbon tax in place, there would be no need for corporate average fuel economy standards, for example. California's emissions-trading scheme, likewise, would be superfluous, and its retention only harmful to the Golden State. As regulations impose significant costs and distort markets, the potential to displace a fairly broad swath of environmental regulations with a carbon tax offers benefits beyond GHG reductions.

- **Price-Stabilization.** As the experiences of the European ETS and California's RECLAIM show us, pollution-trading schemes can be easily gamed, resulting in significant price volatility for permits. Imagine one's energy bill jumping around as permits become more or less available due to small changes in economic conditions. A carbon tax would be predictable, and by raising the overall price of energy to include the tax, the portion of energy cost per unit that stems from fluctuation in market rates for fossil fuels shrinks as a percentage of the whole. That shrinkage makes the price of a given form of energy less susceptible to volatility every time there is a movement in the underlying production costs.

- **Adjustability and Certainty.** A carbon tax, if found to be too stringent, could be relaxed relatively easily over a timeframe, allowing for markets to react with certainty. If found too low to produce results, a carbon tax could easily be increased. In either event, such changes could be phased in over time, creating predictability and allowing an ongoing reassessment of effectiveness via observations about changes in the consumption of various forms of energy. A cap-and-trade system, by contrast, is more difficult to adjust because permits, whether one is the seller or the buyer, reflect significant monetary value. Permit traders would demand—and rightly so—compensation if what they purchased in good faith has been devalued by a governmental deflation of the new "carbon currency." In addition, sudden changes in economic conditions could lead to significant price volatility in a cap-and-trade program that would be less likely under a carbon-tax regime.

- **Preexisting Collection Mechanisms.** Whether at local, state, or federal levels, carbon taxes could be levied and collected through existing institutions with extensive experience in enforcing compliance, and through ready-made statutes to back up their actions. The same cannot be said for emissions-trading schemes that require the creation of new trading markets, complete with new regulations and institutions to define and enforce the value of credits.

- **Keeping Revenue In-Country.** Unlike an international cap-and-trade regime, carbon taxes—whether done domestically or as an internationally agreed-upon value—have the advantage of keeping tax payments within individual countries. This could strongly reduce the opposition to international action that has, until this point, had a strong implication of wealth redistribution overlaid on the policy discussion.

This dynamic leads to a second reason why a carbon tax is a better fit for U.S. climate policy: it offers an international analogue to our federalist approach to public policy innovation within the United States. As we have seen, there is reason to doubt the long-run effectiveness and sustainability of the EU's emissions-trading program. If the United States adopts a carbon tax approach, we will be able to compare the effectiveness of tax versus emissions trading in short order.

- **Mitigation of General Economic Damages.** As energy is one of the three most important variable inputs to economic production (along with labor and capital), raising the cost of energy would undoubtedly result in significant economic harm. Using the revenues generated from a carbon tax to reduce other taxes on productivity (taxes on labor or capital) could mitigate the economic damage that would be produced by raising energy prices. The most likely candidates for a carbon tax tradeoff would be the corporate income tax (the U.S. rate is currently among the highest in the industrialized world) and payroll taxes, the latter of which would lower the cost of employment and help offset the possibly regressive effects of higher energy prices on lower-income households. But across-the-board income tax rate cuts and further cuts in the capital gains tax could also be considered.

  Few other approaches offer this potential. Regulatory approaches such as increasing vehicle efficiency standards do not because they mandate more expensive technologies and allow the costs to be passed on to consumers without offsets (unless they are subsidized), in which case it is the general taxpayer whose wallet shrinks. Emissions-trading would allow for this if one auctioned all initial permits and used the revenue to offset other taxes. The vast majority of trading systems, however, begin with the governing entity distributing free emission credits to companies based on historical emission patterns rather than having an open auction for permits that would produce such revenue streams. Without an auction, the revenues in a trading scheme accrue only to private companies that trade in carbon permits, while the companies buying permits would pass the cost on to consumers. International emissions-trading approaches such as Kyoto's clean development mechanism are worse still: the beneficiaries of the scheme are likely to be foreign governments or private entities that can reduce (or pretend to reduce) carbon emissions more efficiently, leaving Americans with higher energy prices and no revenue stream to offset the negative impacts on productivity.

Exploring the Parameters of Carbon-Centered Tax Reform

Published estimates of an initial optimal carbon tax on fuels are in the range of \$10 to \$20 per ton of CO_2 emitted (in 2005 dollars). Nordhaus, for example, estimates the optimal rate for a tax implemented in 2010 to be \$16 per ton of carbon and rapidly rising over time.[14] We will focus primarily on a tax rate of \$15 per ton of CO_2, while also providing enough information to allow a reader to consider the likely impact of a range of possible taxes.

- **Background on Emissions.** According to the U.S. Energy Information Administration, emissions of CO_2 in the United States in 2005 equaled 6,009 million metric tons (MMT) of CO_2, an increase of twenty MMT over 2004.[15] Emissions have grown at an annual rate of 1.2 percent between 1990 and 2005. Recently, the rate has slowed, with the average annual rate between 2000 and 2005 equaling 0.5 percent.

- **Price Impacts.** Table 1, on the following page, shows the price impacts of a \$15 per ton CO_2 tax under the assumption that the tax is fully passed forward. The price shown for gasoline is not in addition to that on crude oil (i.e., it is not a double-tax). It is included to show how the price levied on crude oil would change the price of the refined product.[16] This provides a rough guide to the excise tax equivalent price impacts of a tax on CO_2. We can scale the tax rates to evaluate different carbon taxes. For example, a \$10 per ton tax on CO_2 would raise the price of coal by \$28.55 x 0.66 = \$18.84.

  A \$15 CO_2 tax would raise the price of gasoline by 14¢ per gallon. A similar calculation can be made for coal-fired electricity. Using the most recent data from EPA's Emissions & Generation Resource Integrated Database (eGRID), we calculate that the average emission rate for coal-fired power plants is 2,395 pounds of CO_2 per megawatt-hour (MWh) of electricity. A \$15 per ton CO_2 tax would raise the price of coal-fired electricity by 1.63¢ per kilowatt-hour (kWh), or 20 percent at an average electricity price of 8.3¢ per kWh.

Table 2 shows the impact of a $15 per ton carbon tax on the price of major fuels used in electricity generation. Fuel prices are prices at which the carbon tax would likely be applied.[17] Not surprisingly, coal is most heavily impacted by a carbon tax, with coal's price rising by more than three-quarters with a tax of this magnitude.

- **Behavioral Responses and Revenue.** The higher energy prices in table 2 should bring about a reduction in the demand for carbon-intensive fuels. A full analysis of equilibrium changes in carbon emissions requires a Computational General Equilibrium (CGE) model, an exercise that is beyond the scope of this paper. We can, however, make a rough calculation using previously published results from CGE models. Here, we extrapolate results from the analysis of Bovenberg and Goulder of a $25 per ton tax on carbon.[18] Table 3 presents the price and output changes for fossil fuels following the imposition of the carbon tax in Bovenberg and Goulder's study. We compute the arc elasticity as the ratio of the percentage output change to price change.

These response elasticities are not price elasticities in the usual sense, since they are the outcome of the entire general equilibrium response to the tax. These responses, for example, include a shift in electricity production away from coal toward natural gas and oil.[19] They are also relatively short-run responses, on the order of three to five years following the phased-in introduction (over three years) of the carbon tax.

The elasticities from table 3 combined with the price increases in table 2 imply the reductions in fuel use and carbon emissions seen in table 4.

TABLE 1

PRICE IMPACTS OF A $15 CO_2 TAX

Energy Unit	Coal Short Ton	Crude Oil Barrel	Natural Gas mcf	Gasoline Gallon
MT C/Quad Btu	25,980,000	20,300,000	14,470,000	19,340,000
Mt CO_2/Quad Btu	95,260,000	74,433,333	53,056,667	70,913,333
Btu/Energy Unit	19,980,000	5,800,000	1,027,000	124,167
Mt CO_2/Energy Unit	1.903	0.432	0.054	0.009
Tax/Energy Unit	$28.55	$6.48	$0.81	$0.14

SOURCES: Carbon content of fuels from www.eia.doe.gov/environment.html; energy content of fuels from U.S. Department of Energy (DOE), Energy Information Administration (EIA), *Annual Energy Review 2005*, DOE/EIA-0384(2005), Washington, DC: EIA, 2006.

TABLE 2

SHORT-RUN PRICE EFFECTS OF A $15 CO_2 TAX

Energy Source	Unit	Price Per Unit ($)	Tax Per unit of Energy	Price Change (%)
Coal	short ton	$34.29	28.55	83.3
Crude Oil	barrel	$60.23	6.48	10.8
Natural Gas	million cubic feet	$8.53	0.82	9.6

SOURCE: Prices are 2006 averages as reported by Energy Information Administration (EIA). Coal statistics from EIA, "Receipts, Average Cost and Quality of Fossil Fuels," available at www.eia.doe.gov/cneaf/electricity/epm/table4_2.html; crude oil statistics from EIA, "Refiner Acquisition Cost of Crude Oil," available at http://tonto.eia.doe.gov/dnav/pet/pet_pri_rac2_dcu_nus_a.htm; and natural gas statistics from EIA, "Natural Gas Prices," available at http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm. Unit taxes computed from table 1.

NOTE: Tax is assumed to be fully passed forward.

TABLE 3

IMPLIED OUTPUT ELASTICITIES

	Price Change (%)	Output Change (%)	Output Elasticity
Coal Mining	54.50	-19.10	-0.350
Oil	13.20	-2.10	-0.159
Natural Gas	13.20	-2.10	-0.159

SOURCE: A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" in *Distributional and Behavioral Effects of Environmental Policy*, eds. Carlo Carraro and Gilbert E. Metcalf (Chicago: University of Chicago Press, 2000), table 2.2.

NOTE: Output elasticity is the ratio of the percent change in quantity demanded divided by the percent change in price, multiplied by negative one.

As table 4 shows, CO_2 emissions are reduced by 663 million metric tons, a decline of 11 percent. Most of the reduction in emissions comes from reduced coal use. A static estimate of CO_2 tax revenue (ignoring the behavioral response) suggests that a $15 tax would raise $90.1 billion per year in the near term.[20] Allowing for the emissions reductions calculated in table 4, the tax would raise $80.2 billion per year. Clearly, the tax would raise less money in future years as greater reductions in carbon emissions occurred through improvements in efficiency, fuel switching, or new technologies like carbon capture and sequestration.[21] The revenue estimate, however, does not factor in growth in demand for electricity nor the baseline growth in carbon emissions that would result in the absence of any carbon policy.

Applying this approach to different carbon tax rates gives the results for emissions reductions and tax revenues seen in table 5.

While these results are useful for providing a ballpark estimate of the impact of a carbon tax, more detailed modeling will be required to refine them further. Our estimates are broadly consistent with results from more detailed CGE modeling of U.S. carbon policies.[22]

TABLE 4
EMISSIONS REDUCTIONS FOR A $15 TAX

Energy Source	Output Change (%)	CO_2 Emissions (MMT)	Reduction in CO_2 Emissions (MMT)
Coal	–29.2	2,046	597.1
Crude Oil	–1.7	2,832	48.4
Natural Gas	–1.5	1,130	17.2
Total	N/A	6,009	662.8

SOURCE: Authors' calculations.

TABLE 5
VARYING THE TAX RATE

Tax Rate Per Ton ($)	Emissions Reductions (%)	Tax Revenue ($ billions, annual rate)
10	7.40	55.7
15	11.0	80.2
20	14.7	102.5
25	18.4	122.6

SOURCE: Authors' calculations.

TABLE 6
CARBON TAXES AS A SHARE OF OTHER TAXES

Tax Rate Per Ton ($)	Tax Revenue ($ billions)	Personal Income Tax (%)	Corporate IncomeTax (%)	Payroll Taxes (%)
10	55.7	6.0	20.0	7.0
15	80.2	8.6	28.8	10.1
20	102.5	11.1	36.8	12.9
25	122.6	13.2	44.1	15.4

SOURCE: Authors' calculations.

- **Potential Uses of Revenue.** Carbon tax revenues could be used for a number of purposes, such as lowering payroll and corporate income taxes, funding tax relief to low-income earners most affected by increased energy prices, or a combination of these. Table 6 reports the carbon tax revenue from table 5 as a percentage of various tax collections in 2005, as reported in the most recent administration budget submission.

A $15 per ton CO_2 tax raises enough revenue to reduce the corporate income tax by over one-quarter and income or payroll taxes by roughly 10 percent. In a policy brief for the Brookings Institution and the World Resources Institute, economist Gilbert Metcalf estimated that a rebate of the employer and employee payroll tax contribution on the first $3,660 of earnings per worker in 2003 would be sufficient to make the carbon tax both revenue- and distributionally neutral.[23]

Distributional neutrality may well impact the desirability and political feasibility of a carbon tax, but there are efficiency considerations as well. There is substantial literature on the "double dividend" that examines the economic conditions under which a carbon tax can be paired with a reduction in other taxes in a manner that improves the overall efficiency of the economy. Where such a double dividend is available, a carbon tax swap would be desirable, even if the environmental benefit of reduced carbon emissions failed to be realized.

The concept of the double dividend stems from the observation that a tax on an environmental externality not only helps curb the externality (dividend 1), but also provides revenue with which other distorting taxes can be reduced, thereby providing efficiency gains (dividend 2).[24]

The double dividend comes in different levels.[25] The "weak" double dividend states that if one has an economically distorting tax, using environmental tax proceeds to lower it provides *greater efficiency gains* than returning the proceeds lump sum to those who pay the environmental tax. An intermediate form of the double dividend hypothesis is that there exists a distortionary tax, such that using environmental tax proceeds to lower this tax will *improve welfare*, setting aside environmental benefits.[26] A strong form claims that a welfare gain will occur when environmental proceeds replace those of the typical distorting tax.

A tax swap would create economy-wide incentives for energy efficiency and lower-carbon energy, and by raising the price of energy, would also reduce energy use.

The weak double dividend is uncontroversial,[27] while the strong double dividend is somewhat more controversial.[28] Criticisms notwithstanding, logic suggests that the pursuit of a strong double dividend is desirable as a matter of public policy. To that end, it would seem much more desirable in terms of efficiency to pursue capital tax reduction as a revenue feedback than other choices, as the current treatment of capital in the tax code is quite far from the optimal tax of zero, and the efficiency gains from a reduction in a payroll tax would likely be minimal if labor is, as is generally accepted, supplied relatively inelastically.

It should be noted that cap-and-trade systems and carbon-tax systems can be designed so they are quite similar. If, for example, emissions are capped and permits are auctioned off, then one could, after observing the auction price, set a carbon tax that leads to a similar emissions and revenue outcome. Cap-and-trade systems, however, generally have been pursued as an alternative to revenue-raising taxes, and often allocate the permits according to some formula rather than through an auction. For the purposes of exposition, we compared a carbon tax to this latter form of the cap-and-trade system. One should remember that cap-and-trade proposals can be adjusted to raise revenues, and the revenues could then be used to pursue the double dividend. In that case, the relative merits of a carbon tax would be diminished.

Achieving a More Efficient System

A cap-and-trade approach to controlling GHG emissions would be highly problematic. A lack of international binding authority would render enforcement nearly impossible, while the incentives for cheating would be extremely high. The upfront costs of creating institutions to administer trading are significant and likely to produce entrenched bureaucracies that clamor for ever-tighter controls on carbon emissions. Permit holders will see value in further tightening of caps, but will resist efforts outside the cap-and-trade system that might devalue their new carbon currency. Higher energy costs resulting from trading would lead to economic slowdown, but as revenues would flow into for-profit coffers (domestically or internationally), revenues would be unavailable for offsetting either the economic slowdown or the impacts of higher energy prices on low-income earners.

A program of carbon-centered tax reform, by contrast, lacks most of the negative attributes of cap-and-trade, and could convey significant benefits unrelated to GHG reductions or avoidance of potential climate harms, making this a no-regrets policy. A tax swap would create economy-wide incentives for energy efficiency and lower-carbon energy, and by raising the price of energy would also reduce energy use. At the same time, revenues generated would allow the mitigation of the economic impact of higher energy prices, both on the general economy and on the lower-income earners who might be disproportionately affected by such a change. Carbon taxes would be more difficult to avoid, and existing institutions quite adept at tax collection could step up immediately. Revenues would remain in-country, removing international incentives for cheating or insincere participation in carbon-reduction programs. Most of these effects would remain beneficial even if science should determine that reducing GHG emissions has only a negligible effect on mitigating global warming.

A modest carbon tax of $15 per ton of CO_2 emitted would result in an 11 percent decline in CO_2 emissions, while raising non–coal-based energy forms modestly. Coal-based energy prices would be affected more strongly, which is to be expected in any plan genuinely intended to reduce GHG emissions. A number of possible mechanisms are available to refund the revenues raised by this tax. On net, these tools could significantly reduce the economic costs of the tax and quite possibly provide economic benefits.

For these reasons, we conclude that if aggressive actions are to be taken to control GHG emissions, carbon-centered tax reform—not GHG emission trading—is the superior policy option.

AEI editorial associate Nicole Passan worked with Messrs. Green, Hayward, and Hassett to edit and produce this Environmental Policy Outlook.

Notes

1. United States Environmental Protection Agency (EPA), "Progress Reports," available at www.epa.gov/airmarkets/progress/progress-reports.html.

2. Sequestration projects currently appear to be not only very expensive, but they also reduce net power generation by as much as 20 percent, further aggravating the cost that will be passed along to consumers and rate payers.

3. Robert J. Shapiro, "Addressing the Risks of Climate Change: The Environmental Effectiveness and Economic Efficiency of Emissions Caps and Tradable Permits, Compared to Carbon Taxes," February 2007, 22, available at www.theamericanconsumer.org/Shapiro.pdf.

4. William Nordhaus, "Life after Kyoto: Alternative Approaches to Global Warming Policies" (NBER working paper no. W11889, December 2005), 15.

5. Ibid., 22.

6. Robert J. Shapiro, "Addressing the Risks of Climate Change: The Environmental Effectiveness and Economic Efficiency of Emissions Caps and Tradable Permits, Compared to Carbon Taxes."

7. RECLAIM covered 390 stationary sources of NOx and fourteen stationary sources of SO_2, which represented only 17 percent of total basin-wide NO_x emissions and 31 percent of basin-side SO_2 emissions.

8. The Clean Air Act forbids it, in fact. SCAQMD's RECLAIM regulations read: "An RTC [RECLAIM Trading Credit] shall not constitute a security or other form of property." Section 4 of the RECLAIM regulations reiterated this point: "Nothing in District rules shall be construed to limit the District's authority to condition, limit, suspend, or terminate any RTCs or the authorization to emit which is represented by a Facility Permit." (Cited in James L. Johnston, "Pollution Trading in La-La Land," *Regulation* [Fall 1991], available at www.cato.org/pubs/regulation/reg17n3-johnston.html.)

9. Carbon Tax Center, "Who Supports," available at http://carbontax.wrkng.net/who-supports/.

10. William Pizer, "Choosing Price or Quantity Controls for Greenhouse Gases," *Resources for the Future Climate Issues Brief* 17 (July 1999).

11. Louis Kaplow and Steven Shavell, "On the Superiority of Corrective Taxes to Quantity Regulation," *American Law and Economics Review* 4, no. 1 (2002).

12. William Pizer, "Choosing Price or Quantity Controls for Greenhouse Gases."

13. William Nordhaus, "Life after Kyoto: Alternative Approaches to Global Warming Policies," 15.

14. Ibid.

15. U.S. Department of Energy (DOE), Energy Information Administration (EIA), *Emissions of Greenhouse Gases in the United States 2005*, DOE/EIA-0573(2005), Washington, DC: DOE, 2006. Total GHG emissions equaled 7,147 million metric tons CO_2 equivalent using hundred-year global warming potentials. Note that a simple conversion of other GHGs (i.e., methane, nitrous oxides, HFCs, and PFCs) does not exist. The global warming potential depends on the time horizon. We focus on CO_2 only in this study, though, ideally, a carbon tax would also tax these non-CO_2 emissions.

16. This is a standard assumption borne out by CGE modeling. See, for example, A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" in *Distributional and Behavioral Effects of Environmental Policy*, eds. Carlo Carraro and Gilbert. E. Metcalf (Chicago: University of Chicago Press, 2000), 45–85.

17. We assume the tax on coal would be applied for electric utilities and major industrial coal users. Note that 91 percent of domestic and imported coal is consumed by electric utilities. (DOE, EIA, *Emissions of Greenhouse Gases in the United States 2005*.) The tax on crude oil is levied at refineries, and the tax on natural gas at the city gate.

18. A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?"

19. Increased coal prices could also lead to increased demand for imported oil, an important policy consideration outside the scope of this paper.

20. Carbon taxes can be reported in either units of carbon or CO_2. To convert a tax rate per unit of carbon dioxide to a rate per unit of carbon, multiply the CO_2 rate by 44/12 (the mass difference between carbon and CO_2). Thus, a tax of \$10 per ton of CO_2 is equivalent to a tax of \$36.67 per ton of carbon.

21. The recent coal study by researchers at the Massachusetts Institute of Technology suggests that carbon capture and sequestration is cost competitive at a carbon price of \$30 per ton of CO_2. See John Deutch and Ernest Moniz, *The Future of Coal* (Massachusetts Institute of Technology, 2007), available at http://web.mit.edu/coal/.

22. Sergey Paltsev et al., *Assessment of U.S. Cap-and-Trade Proposals*, report 146 (Cambridge, MA: MIT Joint Program on the Science and Policy of Global Change, 2007), available through http://mit.edu/globalchange/www/abstracts.html#top.

23. Gilbert Metcalf, *A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief* (Washington, DC: Brookings Institution–World Resources Institution, 2007).

24. Don Fullerton and Gilbert E. Metcalf, "Environmental Taxes and the Double Dividend Hypothesis: Did You Really Expect Something for Nothing?" *Chicago-Kent Law Review* 73, no. 1 (1998): 221–56.

25. See Lawrence H. Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide," *International Tax and Public Finance* 2 (1995): 157–83, for a thorough taxonomy of the various double dividends. Also see A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?"

26. The terminology of intermediate and strong double dividends is due to Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide."

27. Mustafa Babiker, Gilbert E. Metcalf, and John Reilly, "Tax Distortions and Global Climate Policy," *Journal of Environmental Economics and Management* 46 (2003): 269–87. Babiker et al. show that it is possible, however, to find taxes such that lump-sum replacement dominates, lowering a distortionary tax.

28. A. Lans Bovenberg and Ruud de Mooij, "Environmental Levies and Distortionary Taxation," *American Economic Review* 84, no. 4 (1994): 1085–89. See also Lawrence H. Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide."

Los Angeles Times
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From the Los Angeles Times

A WARMING WORLD

Time to tax carbon

A carbon tax is the best, cheapest and most efficient way to combat cataclysmic climate change.

May 28, 2007

IF YOU HAVE KIDS, take them to the beach. They should enjoy it while it lasts, because there's a chance that within their lifetimes California's beaches will vanish under the waves.

Global warming will redraw the maps of the world. The U.N.'s Intergovernmental Panel on Climate Change predicts that sea levels will rise 7 to 23 inches by the end of the century; as the water gets higher, the sandy beaches that make California a tourist magnet will be washed away. Beachfront real estate will end up underwater, cliffs will erode faster, sea walls will buckle and inlets will become bays. The water supply will be threatened as mountain snowfall turns to rain and the Sacramento-San Joaquin Delta faces contamination with saltwater. Droughts will likely become more common, as will the wildfires they breed.

Global warming is happening and will accelerate regardless of what we do today, but the scenarios of climatologists' nightmares can still be avoided. Though the cost will be high, it pales in comparison to the cost of doing nothing.

The proposed fixes for climate change are as numerous as its causes. Most only tinker at the edges of the problem, such as a California bill to phase out energy-inefficient lightbulbs. To produce the cuts in greenhouse gases needed to slow or stop global warming, the world will have to phase out the fossil fuels on which it relies for most of its power supply and transportation — especially the coal-burning power plants that account for about 32% of the annual emissions of carbon dioxide in the U.S. and that generate about half of our electricity. There are three basic methods of doing that, which are the subject of debate and legislation at every level of government.

Tax or trade?

The first is the simplest, and the least efficient: Just order the polluters to clean up. Unfortunately, that's the strategy favored by the Legislature, which last year ordered that greenhousegas emissions in California be cut by 25% by 2020 and is now coming up with ways to meet the goal through conservation and regulation.

The law isn't specific about how to achieve the reduction, opening the door for Gov. Arnold Schwarzenegger to pursue Method No. 2: a cap-and-trade system. Under this system, the government decides how many tons of a given greenhouse gas can be emitted statewide and passes out credits to the emitters. Polluters trade credits among themselves; those for whom it's relatively cheap to cut emissions sell credits to those for whom it's expensive. In the last year, Schwarzenegger has been traveling around the country and the world signing cap-and-trade deals.

The difference between these methods is that the Legislature wants to impose a cap without any trade. This "command and control" strategy is extremely punitive to some polluters, such as utilities that rely heavily on dirty, old coal plants. Many will find it impossible to meet the state goal, exposing them to harsh fines — the costs of which they'll pass on to their customers. Of all possible approaches, it would have the worst effect on the state economy.

Cap-and-trade isn't just less expensive, it has proved to be workable. In 1995, the federal government launched a cap-and-trade program for sulfur dioxide, the main ingredient in acid rain. The goal was to reduce emissions to half their 1980 levels by 2010, and the program is expected to reach it or fall just short. It has become a model worldwide, leading signatories to the Kyoto Protocol to pursue an international cap-and-trade system for greenhouse gases. Moreover, the carbon-trading concept has widespread political and business support — even such gargantuan polluters as Duke Energy, BP America and General Motors have joined a corporate coalition calling for a federal cap-and-trade program.

And yet for all its benefits, cap-and-trade still isn't the most effective or efficient approach. That distinction goes to Method No. 3: a carbon tax. While cap-and-trade creates opportunities for cheating, leads to unpredictable fluctuations in energy prices and does nothing to offset high power costs for consumers, carbon taxes can be structured to sidestep all those problems while providing a more reliable market incentive to produce clean-energy technology.

Europeans strike out

To understand the drawbacks of cap-and-trade, one has to look not only at the successful U.S. acid rain program but the failed European Emissions Trading Scheme, the first phase of which started in January 2005. European Union members each developed emissions goals, then passed out credits to polluters. Yet for a variety of reasons, the initial cap was set so high that the polluters fell under it without making any reductions at all. The Europeans are working to improve the scheme in the next phase, but their chances of success aren't good.

One reason is the power of lobbyists. In Europe, as in the U.S., special interests have a way of warping the political process so that, for example, a corporation generous with its campaign contributions might win an excessive number of credits. It's also very easy in many European countries to cheat; because there aren't strong agencies to monitor and verify emissions, companies or utilities can pretend they're cleaner than they are.

The latter problem might be avoided in the U.S. by beefing up the Environmental Protection Agency. But there's reason to suspect that many of the corporate interests pushing for a federal cap-and-trade program are hoping for a seat at the table when credits are passed out, and they will doubtless fudge numbers to maximize their credits; some companies stand to make a great deal of money under a trading system. Also hoping to profit, honestly or not, would be carbon traders. Large financial institutions would jump into the exchange to collect commissions on carbon trades, just as they do with crude oil and wheat. This presents opportunities for Enron-style market manipulation.

Cap-and-trade would also have a nasty effect on consumers' power bills. Say there's a very hot summer week in California. Utilities would have to shovel more coal to produce more juice, causing their emissions to rise sharply. To offset the carbon, they would have to buy more credits, and the heavy demand would cause credit prices to skyrocket. The utilities would then pass those costs on to their customers, meaning that power bills might vary sharply from one month to the next.

That kind of price volatility, which has been endemic to both the American and European cap-and-trade systems, doesn't just hurt consumers. It actually discourages innovation, because in times when power demand is low, power costs are low, and there is little incentive to come up with cleaner technologies. Entrepreneurs and venture capitalists prefer stable prices so they can calculate whether they can make enough money by building a solar-powered mousetrap to make up for the cost of producing it.

Carbon taxes avoid all that. A carbon tax simply imposes a tax for polluting based on the amount emitted, thus encouraging polluters to clean up and entrepreneurs to come up with alternatives. The tax is constant and predictable. It doesn't require the creation of a new energy trading market, and it can be collected by existing state and federal agencies. It's straightforward and much harder to manipulate by special interests than the politicized process of allocating carbon credits.

And it could be structured to be far less harmful to power consumers. While all the added costs under cap-and-trade go to companies, utilities and traders, the added costs under a carbon tax would go to the government — which could use the revenues to offset other taxes. So while consumers would pay more for energy, they might pay less income tax, or some other tax. That could greatly cushion the overall economic effect.

Taxes a tough sell

There is a growing consensus among economists around the world that a carbon tax is the best way to combat global warming, and there are prominent backers across the political spectrum, from N. Gregory Mankiw, former chairman of the Bush administration's Council on Economic Advisors, and former Federal Reserve Chairman Alan Greenspan to former Vice President Al Gore and Sierra Club head Carl Pope. Yet the political consensus is going in a very different direction. European leaders are pushing hard for the United States and other countries to join their failed carbon-trading scheme, and there are no fewer than five bills before Congress that would impose a federal cap-and-trade system. On the other side, there is just one lonely bill in the House, from Rep. Pete Stark (D-Fremont), to impose a carbon tax, and it's not expected to go far.

The obvious reason is that, for voters, taxes are radioactive, while carbon trading sounds like something that just affects utilities and big corporations. The many green politicians stumping for cap-and-trade seldom point out that such a system would result in higher and less predictable power bills. Ironically, even though a carbon tax could cost voters less, cap-and-trade is being sold as the more consumer-friendly approach.

A well-designed, well-monitored carbon-trading scheme could deeply reduce greenhouse gases with less economic damage than pure regulation. But it's not the best way, and it is so complex that it would probably take many years to iron out all the wrinkles. Voters might well embrace carbon taxes if political leaders were more honest about the comparative costs.

The world is under a deadline. Some scientists believe that once atmospheric carbon dioxide levels have doubled from the pre-industrial level, which may happen by mid-century if no action is taken, the damage may be irreversible.

CHOOSING PRICE OR QUANTITY CONTROLS FOR GREENHOUSE GASES

William Pizer

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Choosing Price or Quantity Controls for Greenhouse Gases

William Pizer, Resources for the Future

I. Introduction

Much of the debate surrounding climate change has centered on verifying the threat of climate change and deciding the magnitude of an appropriate response. After years of negotiation, this effort led to the 1997 signing of the Kyoto Protocol, a binding commitment by industrialized countries to reduce their emissions of carbon dioxide to slightly below 1990 recorded levels. Without approving or disapproving of the response effort embodied in the Kyoto Protocol, I believe that an important element has been ignored. Namely, should we specify our response to climate change in terms of a quantitative target?

The appeal of a quantitative target is obvious. A commitment to a particular emissions level provides a straightforward measure of environmental progress as well as compliance. Commitment to an emissions tax, for example, offers neither a guarantee that emissions will be limited to a certain level nor an obvious way to measure a country's compliance (when other taxes and subsidies already exist). Yet, it is precisely this concern which points to an important observation.

Quantity targets guarantee a fixed level of emissions. Emission taxes guarantee a fixed financial incentive to reduce emissions. Both can be set at either aggressive or modest levels. Aside from the appeal of the known and verifiable emissions levels that quantity targets can ensure, might there be other important differences between price and quantity controls?

Economists would say yes. With uncertain outcomes and policies that are fixed for many years, it is important to carefully consider both the costs and benefits of alternate price and quantity controls in order to judge which is best. My own analysis of the two approaches indicates that price-based greenhouse gas (GHG) controls are much more desirable than quantity targets, taking into account both the potential long-term damages of climate change and the costs of GHG control. This can be argued on the basis of both theory and numerical simulations. Based on the latter, I find that price mechanisms produce expected net gains *five times higher* than even the most favorably designed quantity target.

To explain this conclusion, I first characterize the differences between price and quantity controls for GHGs. I then present both theoretical and empirical evidence that price-based controls are preferable to quantity targets based on these differences. Finally, I discuss how price controls can be implemented *without* a general carbon tax. This last point is particularly salient for the United States, where taxes are generally unpopular. The "safety valve," as it is often called, involves a cap-and-trade GHG system accompanied by a specified fee or penalty for emissions beyond the initial cap.

II. How do quantity- and price-based mechanisms work?

A quantity mechanism—usually referred to as a permit or cap-and-trade system—works by first requiring individuals to obtain a permit for each ton of carbon dioxide they emit, and then limiting the number of permits to a fixed level.[1] This permit requirement could be imposed on the individuals who actually release carbon dioxide into the atmosphere by burning coal, petroleum products, or natural gas. However, unlike emissions of conventional pollutants which depend on a variety of other factors, carbon dioxide emissions can be determined very accurately by the volume of fuel being used. Rather than requiring *users* of fossil fuels to obtain permits, we could therefore require *producers* to obtain the same permits. This has the advantage of involving far fewer individuals in the regulatory process, thereby reducing both monitoring and enforcement costs (see the papers by Carolyn Fischer, Suzi Kerr and Michael Toman in Further Readings). This type of system has been used with considerable success in the United States to regulate both sulfur dioxide and lead.

A key element in a permit system is that individuals are free to buy and sell existing permits in an effort to obtain the lowest cost of compliance for themselves, in turn leading to the lowest cost of compliance for society. In particular, when individuals observe a market price for permits, those that can reduce emissions more cheaply will do so in order to either sell excess permits or avoid having to buy additional ones. Similarly, those who face higher reduction costs will avoid reductions by either buying permits or keeping those they already possess. In this way, total emissions will exactly equal the number of permits while only the cheapest reductions are undertaken.

A price mechanism—usually referred to as a carbon tax or emissions fee—requires the payment of a fixed fee for every ton of CO_2 emitted. Like the permit system, this fee could be levied upstream on fossil fuel producers or downstream on fossil fuel consumers. Either way, we associate a positive cost with emissions of CO_2 and create a fixed monetary incentive to reduce emissions. Such price-based systems have been used in Europe to regulate a wide range of pollutants (although the focus is usually revenue generation rather than substantial emissions reductions).

Like a tradable permit system, price mechanisms are cost-effective. Only those emitters who can reduce emissions at a cost below the fixed fee or tax will choose to do so. Since only the cheapest reductions are undertaken, we are guaranteed that the resulting emission level is obtained at the lowest possible cost.

The important distinction between these two systems is how they adjust when costs change unexpectedly. A quantity or permit system adjusts by allowing the permit price to rise or fall while holding the emissions level constant. A price or tax system adjusts by allowing the level of total emissions to rise or fall while holding the price associated with

[1] Here and throughout this brief, we discuss policies designed to limit carbon dioxide emissions from fossil fuel sources. These emissions constitute the bulk of GHG emissions and are the general focus of most policy discussions. Regardless, the arguments made in this context apply equally well to the regulation of GHG emissions more broadly defined.

emissions constant. Ignoring uncertainty and assuming we know the costs of controlling CO_2, both policies can be used with the same results. Consider the following example:

Suppose we *know* that with a comprehensive domestic CO_2 trading system in place in the United States by the year 2010, a permit volume of 1.2 gigatons of carbon equivalent emissions (GtC) will lead to a $100 permit price per ton of carbon. (1998 US emissions of carbon from fossil fuels are estimated at 1.5 GtC.) In other words, faced with a price incentive of $100 per ton to reduce emissions, regulated firms in the United States will find ways to reduce emissions to 1.2 GtC. Therefore, the same outcome can be obtained by imposing a $100 per ton carbon tax.

III. Uncertainty about costs

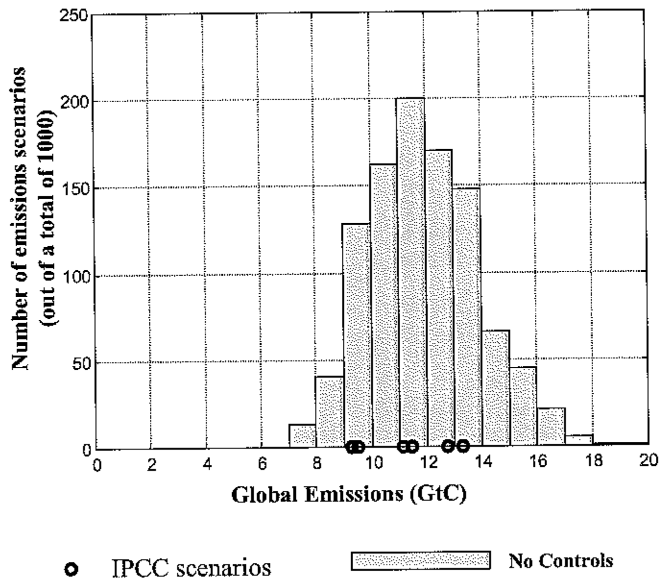
In reality, we have only a vague idea about the permit price that would occur with emissions of 1.2 GtC or any other emission target. There are three reasons why such costs are hard to pin down. First, little evidence exists concerning reduction costs. There are no recent examples of carbon reductions on a substantial scale from which to base estimates. In the 1970's, energy prices doubled and encouraged increased energy efficiency, but these events occurred both in a context of considerable uncertainty about the future and alongside many other confounding factors (such as increased environmental regulation). Alternatively, engineering studies provide a bottom up approach to estimating costs. However, comparisons of past engineering forecasts to actual implementation costs suggest that they are inaccurate at best (see work by Winston Harrington and Richard Morgenstern under Further Readings).

A second source of uncertainty arises because we need to forecast compliance costs in the *future*. This involves difficult predictions about the evolution of new technologies. Proponents of aggressive policy argue that reductions will be cheap as new low-carbon or carbon-free energy technologies become available. Proponents of more modest policies argue that these are unproven, pie-in-the-sky technologies that may never be practical.

Finally, it is impossible to know how uncontrolled emission levels will change in the future. That is, to achieve 1990 emission levels in 2010, it is unclear whether reductions of 5, 25 or even 50% will be necessary. The Intergovernmental Panel on Climate Change (IPCC), the international agency charged with studying climate change, gives a range of six possible global emission scenarios in the year 2010 that include a low of 9 GtC and a high of 13 GtC. My own simulations suggest a broader possible range, from 7 to 18 GtC.

The low end of both ranges reflects the possibility that population and economic growth may slow in the future and the energy intensity of production may fall. The high end reflects the opposite possibility, that growth is high and energy intensity rises. Figure 1 shows the distribution of uncontrolled emissions arising from my simulations of one thousand possible outcomes in 2010 alongside the six IPCC scenarios. (For details on the modeling, see paper by Pizer in Further Readings.)

Figure 1: Distribution of Emissions in 2010



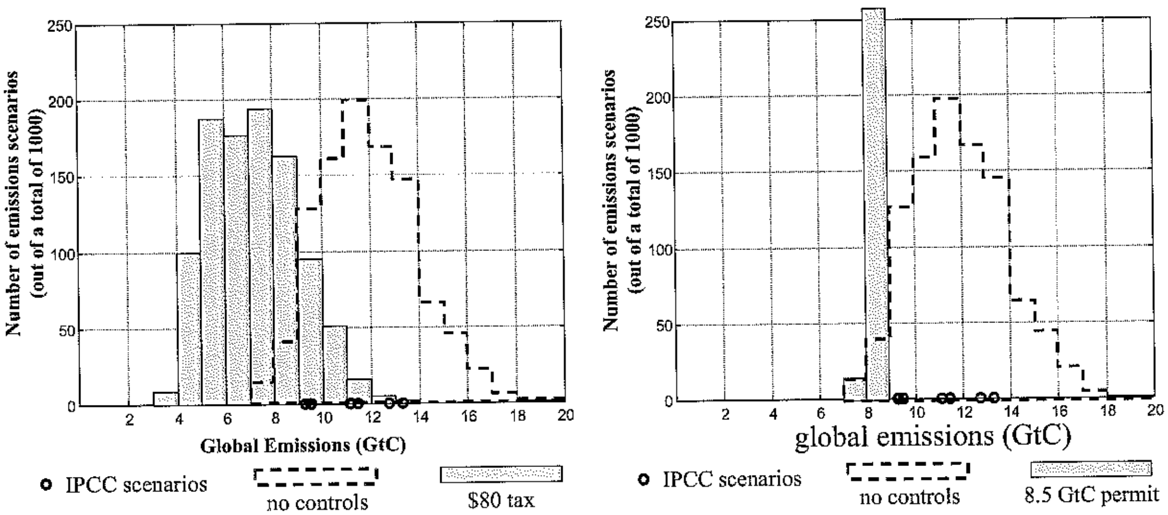
In summary, there are two important reasons why we have only vague ideas about the cost of alternative emission targets. First, there is little historic evidence on costs. Second, as we examine policies ten or more years in the future, it is unclear how both baseline emissions and available technologies will change between now and then. From the preceding figure, global emissions could be anywhere from 7 to 18 GtC in 2010. The cost associated with a 8.5 GtC (1990 level) target will be uncertain both because the necessary reduction is uncertain—somewhere between zero and 10 GtC—and because even knowing the reduction level, costs are difficult to estimate.

IV. Effects of price and quantity controls with cost uncertainty

When the cost of a particular emission target is uncertain, price and quantity controls will have distinctly different consequences for the actual level of emissions as well as the overall cost of a climate policy. Even if both policies are designed to deliver the same results under a best guess scenario, they will necessarily behave differently when control costs deviate from this best guess. These differences arise because a price policy provides a fixed $/ton incentive regardless of the emission level, while a quantity policy generates whatever incentive is necessary in order to strictly limit emissions to a specified level.

Figure 2 illustrates these differences by showing the emission consequences in 2010 associated with two policies that are roughly equivalent under a best-guess scenario: a quantity target of 8.5 GtC and a carbon tax of $80 per ton. Using the same one thousand emission scenarios shown in Figure 1, simulations are used to calculate the effect of these two policies for each outcome. With a carbon tax, the left panel indicates that emissions are below 8.5 GtC in over 75% of the outcomes. In other words, on average the carbon tax achieves *more* reductions than a quantity target of 8.5 GtC. Sometimes, the reductions are much more: note that emissions may be as low as 3 GtC. Yet, the carbon tax fails to *guarantee* that emissions will always be below any particular threshold.

Figure 2: Effect of Price and Quantity Controls on Emissions in 2010

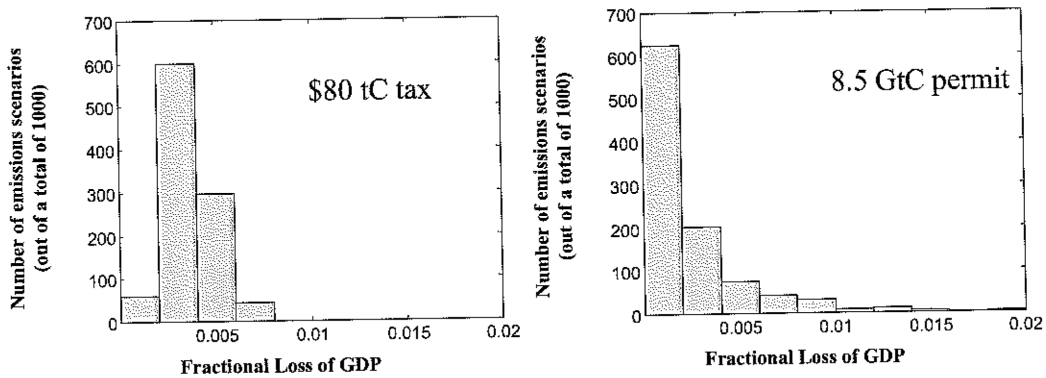


The quantity target, in contrast, never results in emission levels above 8.5 GtC. Since some emission outcomes in the absence of controls were rather high, on the order of 18 GtC, we would expect that the cost of this policy could be quite high. At the other extreme, the quantity policy could be costless if uncontrolled emissions are unexpectedly low.

This suggests that the cost associated with quantity controls will be high or low depending on future reduction costs as well as the future level of uncontrolled emissions. In contrast, price controls create a fixed incentive to reduce each ton of carbon dioxide regardless of the uncontrolled emission level. Therefore, costs under a carbon tax should fluctuate much less than costs under a quantity control.

With this distinction in mind, Figure 3 shows the estimated cost consequences of both policies. The range of costs associated with the quantity target is quite wide as we suspected. The estimates extend from zero to 2.2% of global gross domestic product (GDP). That is almost four times higher than the highest cost outcome under the carbon tax. In fact, the cost associated with emission reductions under a carbon tax are concentrated entirely in the range 0.2% to 0.6% of GDP. Since the carbon tax always applies the same per ton incentive to reduce emissions, the cost outcomes are more narrowly distributed than those occurring under a quantity target.

Figure 3: Distribution of 2010 Costs associated with Price and Quantity Controls



V. Choosing between price and quantity controls

So far the discussion has been limited to the different emission and cost consequences of alternative price and quantity controls. Choosing between them, as well as choosing the appropriate stringency of either policy, requires making judgments about climate change consequences as well as control costs. In order to help us understand when one policy instrument will likely be preferred to the other, it is useful to consider two extreme cases.

First, imagine that there is a known climate change *threshold*. When carbon dioxide emissions are below this threshold, the consequences are negligible. Above this threshold, however, damages are potentially catastrophic. For example, research suggests that the process by which carbon dioxide is absorbed at the surface of the oceans and circulated downward could change dramatically under certain circumstances (see article by Broecker listed in Further Readings). If we further believe that these changes will have severe consequences *and* we can identify a safe emission threshold for avoiding them, then quantity controls seem preferable. Quantity controls can be used to avoid crossing the threshold and, in this case, large expenditures in order to meet the target are justified by the dire consequences of missing it.

Now, imagine instead that every ton of carbon dioxide emitted causes the same incremental amount of damage. These damages might be very high or low, but the key is that each ton of emissions is just as bad as the next. Such a scenario is also plausible, as indicated by a survey of experts including both natural and social scientists who do research on global warming. Their beliefs suggest that the damage caused by each ton of emitted CO_2 may be quite high but that there is no threshold: damages are essentially proportional to emissions. Each additional ton is equally damaging, whether it is the first ton emitted or the last (Tim Roughgarden and Steven Schneider discuss this survey, originally conducted by William Nordhaus; see Further Readings for both references).

In this case, it makes sense to use a price instrument. Specifically, a carbon tax equal to the damage per ton of CO_2 will lead to exactly the right balance between the cost of reducing emissions and the resulting benefits of less global warming. Every time a firm decides to emit CO_2, it will be confronted with an added financial burden equal to the resulting damage. This will lead to reduction efforts as well as investments in new technology that are commensurate with the alternative of climate change damage. In this scenario, little emphasis is placed on reaching a particular emission target because there is no obvious quantity target to choose. This argument applies even if we are uncertain about the magnitude of climate damage per unit of CO_2.

VI. Arguments for Price Policies

Given this characterization of circumstances under which alternative price and quantity mechanisms are preferred, we can now make the argument for price controls. This argument hinges on two basic points. The first point is that climate change consequences generally depend on the *stock* of greenhouse gases in the atmosphere, rather than annual emissions. Greenhouse gases emitted today may remain in the atmosphere for hundreds of years. It is not the level of annual emissions that matters for climate change, but rather the total amount of carbon dioxide and other greenhouse gases that have accumulated in the atmosphere. The second point is that while scientists continue to argue over a wide range of climate change consequences, few advocate an immediate halt to further emission. For example, the most aggressive stabilization target discussed by the IPCC is 450 ppm (roughly 1035 GtC), a level that we will not reach before 2030 even in the absence of emission controls (see the Technical Summary provided in the IPCC report listed in Further Readings).

If only the stock of atmospheric GHGs matters for climate change, and if experts agree that the stock will grow at least in the immediate future, there is virtually no rationale for quantity controls (for further discussion see my paper with Richard Newell in Further Readings). The fact that only the stock matters should first draw our attention away from short-term quantity controls for emissions and toward long-term quantity controls for the *stock*. It cannot matter whether a ton of CO_2 is emitted this year, next year or ten years in the future if all we care about is the total amount in the atmosphere. Taking the next step and presuming that the stock will grow over the next few decades, this suggests that there is some room to rearrange emissions over time and that a short-term quantity control on emissions is unnecessary.

Quantity controls derive their desirability from situations where strict limits are important, when dire consequences occur beyond a certain threshold. Such policies trade off lower expected costs in favor of strict control of emissions in all possible outcomes. However, under the assumption that it is acceptable to allow the stock of greenhouse gases to grow in the interim, there is no advantage to such strict control. We give up the flexible response of price controls without the benefit of an avoided catastrophe.

Even for those who believe the consequences of global warming will be dire and that current emission targets are not aggressive enough, price policies are still better. An aggressive policy designed to *eventually* stabilize the stock does not demand a strict limit on emissions before stabilization becomes necessary. Additional emissions this year are no worse than emissions next year. Why not abate more when costs are low and less when costs are high—exactly the outcome under a price mechanism? When we eventually move closer to a point where the stock must be stabilized, a switch to quantity controls will be appropriate.

In addition to these theoretical arguments, one can also turn to integrated assessment models for support. To this end, I have constructed an integrated model of the world economy and climate based on the DICE model developed by William Nordhaus. In contrast to the DICE model, I simultaneously incorporate uncertainty about everything from growth in population and energy efficiency to the cost of emission reductions, to the sensitivity of the environment to atmospheric CO_2 and the damages arising from global warming.

The results of these simulations indicate the price-based mechanisms can generate overall economic gains (expected benefits minus expected costs) that are *five times higher* than even the most prudent quantity-based mechanism. These results are robust. Even allowing for catastrophic damages beyond three degrees centigrade of warming, price mechanisms continue to perform better. This robustness can be explained in two ways. First, the catastrophe, if it exists, lies in the future. Before we reach that point, it is desirable to have some flexibility in emission reductions. Specifically, one will want to delay those reductions if the costs are unexpectedly high in the short run, provided those reductions can be obtained more cheaply in the future but before the catastrophe.

Second, unlike the earlier, stylized description where climate consequences depend directly on CO_2 concentrations, in this model damages instead depend on temperature change. In reality, damages probably depend on an even more complex climatic response. Either way, the link between CO_2 emissions, concentrations, temperature change and other climatic effects are not precisely known. Therefore, a quantity control on *emissions* is not equivalent a quantity control on *climate change*. Both price and quantity controls will lead to uncertain climate consequences. Therefore the advantage of the quantity control—namely its ability to avoid with certainty the threat of climate catastrophe—is substantially weakened.

VII. Combined price and quantity mechanisms

Even if a carbon tax is preferable to a cap-and-trade approach in terms of social costs and benefits, this policy obviously faces steep political opposition in the United States. Businesses oppose carbon taxes because of the transfer of revenue to the government. Under a permit system there is a hope that some, if not all, permits would be given away for free. Environmental groups oppose carbon taxes for an entirely different reason: they are unsatisfied with the prospect that a carbon tax, unlike a permit system, fails to guarantee a particular emission level. Such antagonism from both sides of the debate makes it unlikely that a carbon tax will become part of the US response to the Kyoto protocol.

However, the advantages of a carbon tax can be achieved without the baggage accompanying an actual tax. In particular, a combined mechanism—often referred to as a hybrid or "safety-valve"—can obtain the economic advantages of a tax while preserving at least some of the political advantages of a permit system (other concerns about the revenue aspects of different policies have been discussed by Ian Parry; see Further Readings).

In such a scheme, the government first distributes a fixed number of tradable permits either freely, by auction, or both. The government then provides additional permits to anyone willing to pay a fixed ceiling or "trigger" price. The initial distribution of permits allows the government the flexibility to give away a portion of the right to emit CO_2, thereby satisfying concerns of businesses about government revenue increases. The sale of additional permits at a fixed price then gives the permit system the same compliance flexibility associated with a carbon tax.

With a combined price/quantity mechanism, it will be necessary to consider how both the trigger price and the quantity target should evolve over time. One possibility is to raise the trigger price over time in order to *guarantee* that the quantity target is eventually reached. A second possibility is to carefully choose future trigger prices as a measure of how much we are willing to pay to limit climate change. As we learn more about the costs of future emission reductions, however, this distinction between price and quantity controls will diminish. That is, once uncertainty about future compliance costs is reduced through experience, price and quantity controls can be used to obtain similar cost and emission outcomes.

Operationally, there are potential problems when this safety valve is used in conjunction with international emissions trading, as the Kyoto Protocol allows. In general, there would be a need for either harmonization of the trigger price across countries, or restrictions on the sale of permits from those countries with low trigger prices. Otherwise, there would be an incentive for countries with a low trigger price to simply print and export permits to countries with higher permit prices. This would not only effectively create low trigger prices everywhere, it would also create large international capital flows to the governments of countries with the low trigger prices.

Instead of harmonizing trigger prices, we could alternately set the trigger price low enough to avoid the need for international GHG trades. This may be a desirable end in light of concerns about the indirect economic consequences of large volumes of international GHG trade flows (this point has been made by Warwick McKibbin and Peter Wilcoxen; see Further Readings).

Finally, if we find it desirable to raise the trigger price rapidly, it will be necessary to limit the possibility that permits can be purchased now and held for long periods of time. Otherwise, there will be a strong incentive to buy large volumes of cheap permits now in order to sell them at high prices in the future. This problem is easily addressed by assigning an expiration date for permits as they are issued, for perhaps one or two years in the future.

VIII. Building domestic and international support for a price-based approach

While the safety valve approach is potentially appealing to businesses concerned about the uncertainty surrounding future permit prices, environmental groups will be wary of giving up the commitment to a fixed emission target. Such a commitment is already an integral part of the Kyoto Protocol. Ultimately, however, a strict target policy may lack political credibility and viability. Although a low trigger price would clearly rankle environmentalists as an undesirable loosening of the commitment to reduce emissions, a higher trigger price could allay those fears while still providing insurance against high costs.

Perhaps more controversial than the concept of a safety valve is the fact that a hybrid policy requires setting a trigger price. It extends the debate over targets and timetables to include, based on the trigger price, perceived benefits. Business interests will undoubtedly seek a low trigger price and environmental groups a high trigger price. I believe this is desirable. The debate will focus on the source of disagreement between different groups: namely, the value placed on reduced emissions. Rather than leaning on rhetoric that casts reduction commitments as either the source of the next global recession (according to businesses) or the costless ushering in of a new age of cheaper and more energy efficient living (according to environmentalists), it will be necessary to decide how much we are realistically willing to spend in order to deal with the problem.

While seemingly provocative in its challenge of the core concept of targets and timetables embedded in the Kyoto protocol, some form of the safety valve idea is already part of many countries' notion of their Kyoto commitments. European countries who are likely to implement carbon taxes must have some view as to how they will handle target violations if their tax proposals fail to sufficiently reduce emissions before the end of the first commitment period. Other countries who are considering either a quantity or command-and-control approach likewise must envision a way out if their actual costs begin to surpass their political will to reduce emissions.

Among the many "implicit safety valve" possibilities, one could imagine a more flexible interpretation of existing provisions, such as the Clean Development Mechanism or the use of carbon sinks. Alternatively, Article 27 specifies that parties can withdraw from the Protocol by giving notice one year in advance. A country that foresaw difficulty in meeting its target in the first commitment period could serve notice that it wishes to withdraw before the commitment period ends.

Implicitly, therefore, flexibility in meeting current commitments already exists. Countries can choose to massage their commitments using existing provisions, violate their targets and risk penalties (which have yet to be defined) or simply withdraw. In these cases, however, the outcome and consequence are unclear. The advantage of a price mechanism is that it makes the safety valve concept *explicit* and *transparent*. Establishing a price trigger for additional emissions allows countries, and in turn private economic decision-makers, to approach their reduction commitments with greater certainty about the future. This not only improves the credibility of the Protocol but also its prospects for future success in reducing GHG emissions.

IX. Conclusions

The considerable uncertainty surrounding the cost of international GHG emission targets means that price- and quantity-based policy instruments cannot be viewed as alternative mechanisms for obtaining the same outcome. Price mechanisms will lead to uncertain emission consequences and quantity mechanisms will lead to uncertain cost consequences. Economic theory as well as numerical simulations indicate that the price approach is preferable for GHG control, generating five times the net expected benefit associated with even the most prudent quantity control. The essence of this result is that a rigid quantity target over the next decade is indefensible at high costs when the stock of GHGs is allowed to increase over the same horizon.

Importantly, a price mechanism need not take the form of carbon tax. The key feature of the price policy is its ability to relax the stringency of the target if control costs turn out to be higher than expected. Such a feature can be implemented in conjunction with a quantity-based mechanism as a "safety valve." A quantity target is still set but with the understanding that additional emissions (beyond the target) will be permitted only if the regulated entities are willing to pay an agreed upon trigger price.

This approach can improve the credibility of the Protocol and its prospects for successful GHG emission reductions. This last point is particularly relevant for ongoing climate negotiations. Should the emission incentives and consequences remain ambiguous and uncertain, or should they be made explicit and transparent? Specifying a price at which additional, above-target emissions rights can be purchased provides such a transparent incentive. The current approach does not. While ambiguity may prove to be the easier negotiating route, it may also be a disincentive for true action.

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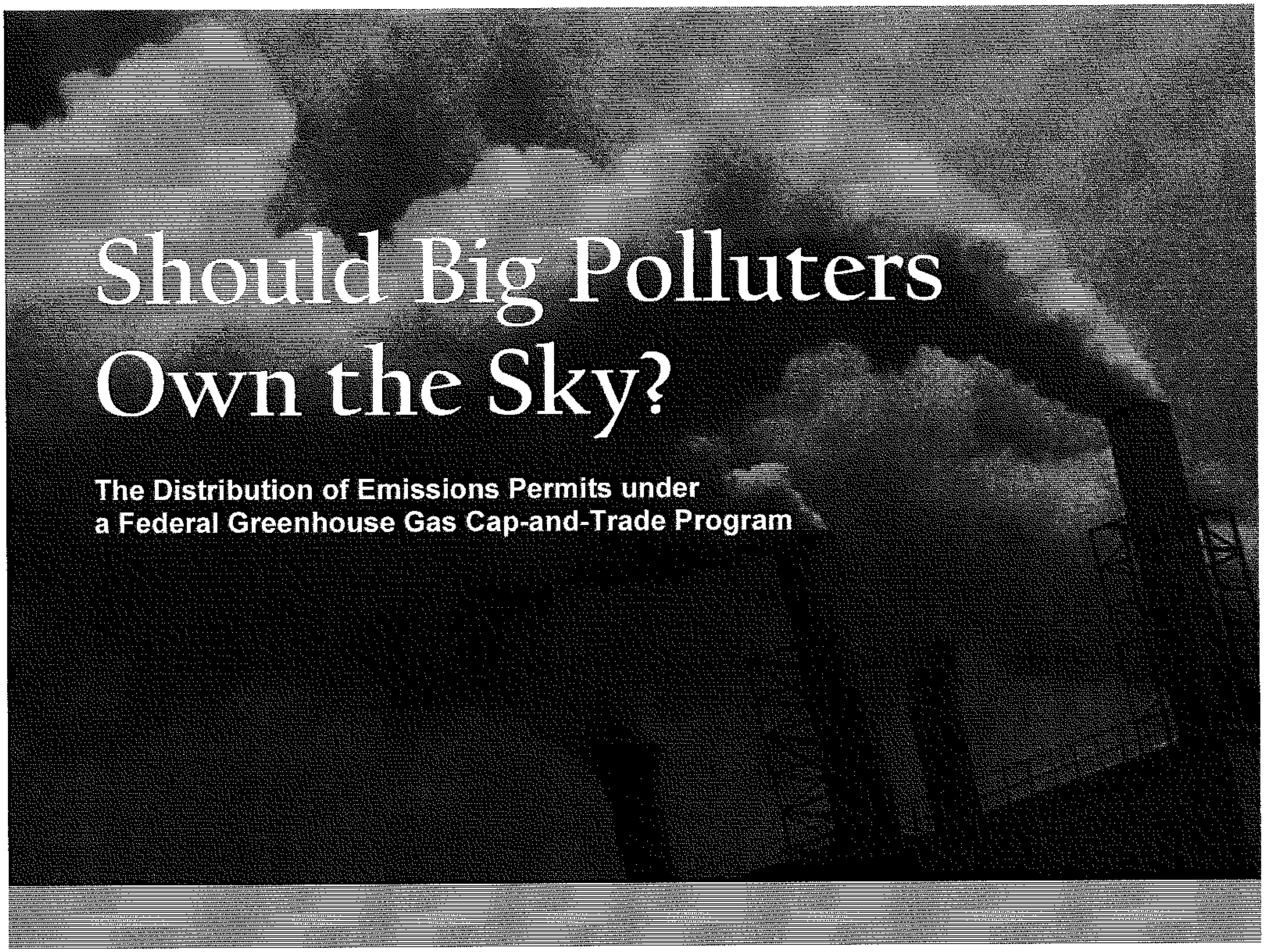

Should Big Polluters Own the Sky?

The Distribution of Emissions Permits under a Federal Greenhouse Gas Cap-and-Trade Program

Clean Air Watch

With a foreword by Larry J. Schweiger,
President and CEO, National Wildlife Federation

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Foreword

Who owns my grandson's future?

That question has haunted me since Thadius was born almost three years ago.

Without urgent action, global warming will, in Thadius's lifetime, visit catastrophic damage upon human communities and unfathomable harm upon the natural world. Few political leaders fully understand that we have precious little time before the planet reaches a tipping point that will trigger untamable, runaway global warming. We need to reclaim our right, and our responsibility, to protect our children from the irreversible changes we stand poised to unleash.

America emits 25 million pounds of global warming pollution into the atmosphere every minute. About 85 percent of this pollution comes from power plants, industrial sources, and the transportation fuels produced by oil companies.

Major corporate carbon emitters could reduce their carbon footprint by improving their energy productivity and by relying more on renewable forms of energy like wind, solar, geothermal and biofuels. But they have little incentive to do so, because they are not required to pay for their carbon emissions or for global warming's effects. After all, when millions of acres of drought-plagued forests and grasslands burn, nobody sends them a bill. When storm surges from rising sea levels flood neighborhoods, nobody sends them a bill. When wildlife and the natural environment that sustains it perish because of shifting climate zones, nobody sends them a bill.

Instead, that bill goes to my grandson and to my children, who will see these effects in their lifetimes.

It's time these companies started getting the bill. We need a pragmatic, market-based plan that attaches a price to carbon emissions. The price must be one that compels corporate polluters promptly to start cutting global warming pollution by at least two percent every year, and by a total of 80% within 40 years, a rate of reduction that scientist predict would allow us to avoid the most catastrophic effects of climate change.

An aggressive, scientifically based cap-and-trade program could achieve such reductions. Fortunately, dozens of responsible companies are expressing support for such a program.

But a cap-and-trade program that does not require companies to pay for carbon permits, and instead gives them away for free in perpetuity, would be fundamentally unjust. No-cost licenses to pollute would deprive the public of the resources and revenues with which to aid the economic transition to a low-pollution world, and with which to address the impacts of global warming. Consider the following:

- Low income American families, which are the least responsible for generating global warming pollution, bear the brunt of climate change's effects. We need carbon credit revenues to help address their needs. For example, implementing a system of incentives for home weatherization would lower families' heating and cooling bills while shrinking their carbon footprint, as could subsidies to offset the sometimes high costs of purchasing energy-efficient appliances.

- Hundreds of millions of the world's poor, who live in nations unable to respond adequately to a rapidly changing planet, are already suffering from the spread of disease, floods from rising sea levels, drought, and dwindling supplies of clean water. Even if we stopped polluting altogether tomorrow to head off the worst impacts of global warming, the pollution we have already pumped into the atmosphere would perpetuate these effects. We have a moral responsibility to financially aid developing nations contending with climate change.

- Building a clean energy economy will create thousands of new jobs and require American workers dependent on the fossil fuel economy to transition into different jobs. We need to be ready to support this transition through job training and other programs that bridge the divide.

- The survival of wildlife species, and the continuation of America's cherished conservation heritage, will depend on investing in a host of mitigation, restoration and management strategies to help wildlife survive a warming planet.

Any fair and effective federal carbon emissions reduction plan will consider all of these interests. The resources to address these needs will be held in public trust by Congress, on behalf of my grandson and all of us.

We are the stewards of our children's future. Let's make sure our voices are heard.

Larry J. Schweiger
President and CEO
National Wildlife Federation

Should Big Polluters Own the Sky?

Executive Summary

As Congress debates the issue of global warming, one key issue involves how emission credits or "allowances" should be distributed under a cap-and-trade system. Simply giving allowances away to polluting companies – as Congress did with the Clean Air Act's acid rain program – could amount to a multi-billion dollar windfall for the nation's biggest polluters, not to mention a virtual monopoly on the combustion of fossil fuels for incumbent utilities. At stake is billions of dollars – the 10 most polluting electric power companies could collectively be awarded $9 billion in allowances annually. The largest emitter of global warming pollution, AEP, could receive ten times the value of its SO_2 allocations under the Acid Rain Program. At the same time, low-income residents could be harmed by a system that simply hands over these windfall profits to private companies.

It seems unconscionable to reward the biggest polluters in this fashion. Why should the polluters profit from the legacy of damage they have caused? Do we really want them to own the sky?

The emissions from the power companies advocating for an approach that would guarantee these windfall profits have released pollution in the past fifty years that still remains in the atmosphere. Giving allowances for free to these polluting companies does not require them to pay for any of the potential consequences caused by their legacy of pollution including sea level rise, increased natural disasters, increased competition for water resources, and adverse health impacts from higher temperatures.

A more thoughtful approach would embody the "polluter pays" principle used in other federal statutes, including the Superfund toxic dump cleanup law with the revenues used to benefit electricity consumers – those who ultimately pay the cost of reducing CO_2 emissions. Rather than giving away these emissions rights, companies should be obligated to purchase allowances. Revenues could be invested in energy efficiency and renewable energy, help for low-income residents, worker transition assistance, protecting wildlife and other socially desirable goals.

Those who pollute the most should pay the most.

Introduction

At least ten bills have been introduced to date in the 110th Congress aimed at cutting global warming pollutants from power plants and other large industrial sources. The majority of the proposals would rely on a "cap-and-trade" regulatory system much like the program established under the Clean Air Act to address acid rain pollution.

The most critical feature of any cap-and-trade program is the stringency of the emissions cap and the timetable for ratcheting down the cap. The cap determines the total quantity of pollution that can be released to the atmosphere by regulated facilities. In the current climate change debate, many stakeholders advocate significant emission reductions – up to 25 percent below current levels by 2020 and 60 to 80 percent below current levels by 2050.

Another critical feature is the method by which the cap – in the form of allowances (each allowance entitles the holder to release 1 ton of pollution to the atmosphere) – is distributed among the power plant operators that need them to run their facilities. The basic options are to sell the allowances to industry (through an auction) or to give them away for free. Not surprisingly, many within industry advocate free allocations. Economists, however, warn of the "windfall profits" that companies would enjoy if allowances are given away for free and strongly recommend an auction approach as a more equitable approach.[1] According to the Congressional Budget Office most of the costs associated with a cap-and-trade program would be borne by consumers, and the price increases, for electricity and gasoline, for example, would be regressive because lower-income households devote a larger fraction of their household income to purchasing energy.[2] By auctioning allowances, rather than simply giving them away, the government generates revenue that can be used to offset these costs and to serve a broader public purpose (e.g., offsetting taxes, consumer rebates, protecting wildlife or technology research and development).

To evaluate the implications of freely distributing allowances to industry, this paper estimates the projected value of a free CO_2 allowance allocation under an electric utility sector cap-and-trade program. For illustrative purposes, this paper focuses on the top ten highest emitting companies in the electric utility sector; companies that generally advocate a free allocation approach.[3]

The top ten highest emitting companies in the U.S. account for approximately 29 percent of total annual U.S. electricity generation, 35 percent of CO_2 emissions, 34 percent of total annual NO_x emissions, 44 percent of SO_2 emissions, and 39 percent of mercury emissions from the electricity sector in the U.S. (See Appendix A for a list of the top ten CO_2 emitting electric utility companies and their contribution to electric sector emissions.) Collectively, the top ten emitting

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[1] *See, e.g.*, Lawerence H. Goulder, *Mitigating the Adverse Impacts of CO2 Abatement Policies on Energy-Intensive Industries*, Resources for the Future (March 2002), *available at* http://www.rff.org/rff/documents/rff-dp-02-22.pdf; Dallas Burtraw et al., *The Effect on Asset Values of the Allocation of Carbon Dioxide Emission Allowances*, Resources for the Future, (March 2002), *available at* http://www.rff.org/Documents/RFF-DP-02-15.pdf.

[2] Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions* (April 25, 2007), *available at* http://www.cbo.gov/ftpdocs/80xx/doc8027/04-25-Cap_Trade.pdf.

[3] *See, e.g.*, Response from Dennis Welch, American Electric Power, to Sens. Domenici and Bingaman's White Paper on Design Elements of a Mandatory Market-Based Greenhouse Gas Regulatory System (February 2006). In its response, AEP explained that "AEP believes strongly that a high percentage of the allowances (e.g., 95%-100%) should be allocated without cost to electric generators based on their pro rata share of historical greenhouse gas emissions."

electric utilities emit over 900 million tons of CO_2 per year. In fact, these ten companies collectively emit more CO_2 on an annual basis than the emissions included in the European Emissions Trading Scheme in the countries of Germany, United Kingdom, and Poland combined.

Overview of Allowance Allocation Issues

How emission allowances are initially distributed has a direct effect on consumer energy costs and on the relative profitability of different types of producers.[4] Ultimately, however, the decision as to how to distribute allowances is political.

Allowance allocations are one of the most contentious decisions in designing a cap-and-trade program, and the issue is shaping up to be a significant point of debate in Congress given the sheer quantity and financial value associated with the allowances in a CO_2 cap-and-trade program. The question is contentious precisely because allowances represent a valuable financial asset.[5] As Senators Pete Domenici and Jeff Bingaman, then Chairman and Ranking Member of the Senate Energy and Natural Resources Committee, explained in a joint letter summarizing the common themes that emerged from their Committee's April 2006 climate change conference: "Allowances should not be allocated solely to regulated entities because such entities do not solely bear the costs of the emissions trading program." The same point is made by the bi-partisan National Commission on Energy Policy: "The economic burden imposed on a particular firm or industry sector under a greenhouse gas trading program is not a direct function of its emissions or fossil-fuel throughput....Available analyses suggest that consumers and businesses at the end of the energy supply chain will bear the largest share of costs under a trading program."[6]

The Financial Value of Allowances

The financial value of the allowances under a future CO_2 cap-and-trade program would very likely dwarf previous cap-and-trade programs – reaching many billions of dollars.

While the actual value of emission allowances in a CO_2 cap-and-trade program would depend on several factors, including, for example, the stringency of the cap and the possibility of offsets, the existing literature and range of CO_2 policies now being debated suggests that the value of emission allowances might total between \$50 billion and \$300 billion per year (in 2007 dollars) by 2020.[7]

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[4] Dallas Burtraw, et al., *CO_2 Allowance Allocation in the Regional Greenhouse Gas Initiative and the Effect on Electricity Investors*, Resource for the Future (Dec. 2005) *available at* http://www.rff.org/Documents/RFF-DP-05-55.pdf.

[5] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System* (March 2007), *available at* http://www.energycommission.org/files/contentFiles/Allocating_Allowances_in_a_Greenhouse_Gas_Trading_System_45f71a5fb536b.pdf.

[6] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System*.

[7] Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions*. The sum value of allowances, however, is not a true measure of the program's cost to society because allowances are an asset of the allowance seller. Rather the cost is equal to the cost of the actual mitigation measures undertaken. (National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System*). For example, under the original National Commission on Energy Policy (NCEP)

To provide context for these large values, consider that the Maryland General Assembly adopted a $30.0 billion budget for fiscal 2008, the New Jersey 2008 proposed state budget is $33.3 billion, and Texas's state budget for 2007 was approximately $75 billion.

The Acid Rain Program - Is it a Model to Follow?

Many electric utility sector companies advocate giving virtually all of the allowances away free of charge to the highest emitting facilities, much like was done under the existing Acid Rain Program, a near 100-percent allocation based on emissions or fuel consumption – with a small percent reserved for annual auctions.[8]

This free allocation approach has proved to be very valuable for electric utilities, especially major emitters of SO_2. For example, in the first ten years of the Acid Rain program (1995-2005), the financial value of the SO_2 allowances allocated to American Electric Power (AEP) – the largest U.S. electricity generator (35,600 MW capacity), the largest consumer of coal in the Western Hemisphere, and the largest emitter of SO_2 in the electricity sector – totaled at least $1.6 billion.[9]

This type of analysis demonstrating the financial contribution that the federal government made to industry under the Acid Rain Program is further supported by the recent experience under the European Union (EU) CO_2 trading program. Under the EU program, most of the countries in the EU opted to allocate all available allowances for free to affected industries. This approach has become extremely controversial within the EU as evidence has emerged that the electric power producers passed on the cost of compliance with the emission limits to the consumers and realized windfall profits as a result of the free allocations.[10]

The Potential for Windfall Profits

Public interest advocates and environmental groups also argue that regardless of whether allowances are provided for free or are sold through an auction, companies will charge customers the same based on the opportunity cost of the allowances.[11] In other words, in order to comply with the CO_2 emissions limit, companies will increase the price of electricity sold to consumers. This price increase generates revenues *and* under a free allocation system, the company would also receive a new asset, the allowances, that the company can then sell on the market. Thus, a

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proposal, the market value of allowances in circulation in the early years of the program would total $30 to $40 billion annually, while the costs incurred by society to actually reduce emissions would be much less (on the order of $4 billion per year).

[8] The SO_2 cap and trade program under the Acid Rain Program initially distributed allowances free of charge to each affected power plant unit based on its heat input during a historical base period (1985–1987), multiplied by an emissions rate calculated such that aggregated emissions equal the target emissions cap. A small portion (2.8 percent) of allowances were withheld from the market and auctioned, with revenues from the auction returned to industry.

[9] See Appendix B for the methodology utilized to estimate the financial value of the SO_2 allowances given to AEP for the first ten years of the Acid Rain Program.

[10] Eric Heymann, *EU Emission Trading: Allocation Battles Intensifying,* Deutsche Bank Research (March 6, 2007), *available at* http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000207573.pdf ("Power generation companies reap hefty windfall profits.").

[11] *See, e.g.*, Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions*; Environmental Defense, *Toward a Fair and Effective Climate Policy for the United States*, response to the U.S. House of Representatives Committee on Energy and Commerce and Subcommittee on Energy and Air Quality (March 19, 2007); Natural Resources Defense Council, Response to the U.S. House of Representatives Committee on Energy and Commerce and Subcommittee on Energy and Air Quality (March 19, 2007).

free allocation system can create two additional revenue sources – the higher priced electricity and the allowances.[12] This system creates a windfall for affected sources, and as discussed above, this situation has borne out in the European CO_2 trading program. Moreover, a recent Congressional Budget Office analysis explains that price increases would disproportionately affect people at the bottom of the income scale.[13] According to the report, a free allocation would increase producers' profits without lessening consumers' costs. This damming assessment of the concept of free allocations should give our Congressional leaders pause before opting for this approach.

Electric power companies operating in traditional regulated power markets assert that they are required to return the value of any allocation to the ratepayer in full and, therefore, oppose the auctioning of allowances. However, these same companies sell power into competitive power markets earning windfall profits, and a perverse outcome can result from the treatment of these allowances. Price increases in regulated power markets may be smaller relative to the increases in unregulated markets. More significantly though, as described below, this argument by the regulated companies runs counter to our society's basic principle that a polluter should pay for any pollution it has released.

The Polluter Pays Principle

Public advocates and environmental groups advocate a larger role for auctioning allowances under a future CO_2 cap-and-trade program citing the precedents created by other environmental programs such as Superfund and the Resource Conservation and Recovery Act (RCRA) under which the polluter pays. For example, under the Superfund program, EPA has the legal authority to: (i) conduct the cleanup and seek recovery from responsible parties, (ii) enter into settlement agreements with the responsible parties, or (iii) compel the responsible parties to conduct a cleanup or pay for the cleanup. Regardless of EPA's use of its authority, the key underlying principle is that responsible parties are joint and severally liable for restitution of any response costs incurred by the government or a private party as a result of a release of hazardous substances. As a result, between 1980 and 2000, the estimated value of private party settlements with EPA is $18 billion.[14] In 2005, based on the polluter pays principle, EPA secured private party funding commitments of more than $1.1 billion.[15] Similarly, RCRA requires the generators, transporters, and treatment, storage, and disposal facilities to comply with RCRA, which can involve remedial action by those responsible for the pollution. Advocates of auctioning CO_2 allowances contend that a CO_2 program should be no different.

Allowances are a public good and should not be given away for free. Instead, polluting companies should be required to purchase the allowances. The revenue from the sale of the allowances could then be utilized for public benefits – including energy efficiency and renewable energy investments, worker transition, habitat preservation, and adaptation to the impacts of

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[12] *See, e.g.*, Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions*; Dallas Burtraw, et. al., *Lessons for a Cap-and-Trade Program* in *Managing Greenhouse Gas Emissions in California*, The California Climate Change Center at UC Berkeley (2006) *available at* http://calclimate.berkeley.edu/5_Cap_and_Trade.pdf.
[13] Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions* (April 25, 2007).
[14] Environmental Protection Agency, *Superfund: 20 Years of Protecting Human Health and the Environment* (December 11, 2000) *available at* http://www.epa.gov/superfund/action/20years/20yrpt1.pdf.
[15] Environmental Protection Agency, *Superfund National Accomplishments Summary Fiscal Year 2005, as of November 22, 2005, available at* http://www.epa.gov/superfund/action/process/numbers05.htm.

climate change (e.g., constructing sea walls). In other words, the polluters would pay for the costs resulting from and made necessary by the CO_2 pollution.

The Acid Rain Allocation Approach Applied to CO_2

As noted above, most of the cost of a CO_2 cap would ultimately be borne by consumers. Giving away nearly all of the allowances to affected energy producers would mean that the value of the allowances received under a CO_2 cap would greatly exceed any cost the companies might bear.[16]

The financial give away would be enormous if the Acid Rain Program approach were used for the allowance allocation in a CO_2 cap-and-trade program. For example, the value of the allowances provided to the top ten emitting electric utility companies would conservatively range from at least \$4.5 billion to \$9 billion per year (assuming allowance prices ranging from \$5-\$10/ton). The table below summarizes this information using 2004 emissions and shows that a free allocation system would provide the greatest subsidy to the highest polluting companies.

Table 1: Top Ten CO_2 Emitting Utilities and Annual Value of a Free Allocation

Company[17]	CO_2 (tons/year)	\$5/ton	\$10/ton
AEP	163,934,554	\$819,672,772	\$1,639,345,543
Southern	148,647,755	\$743,238,776	\$1,486,477,553
Duke	113,602,312	\$568,011,562	\$1,136,023,125
Tennessee Valley Authority	103,602,929	\$518,014,644	\$1,036,029,288
Xcel	69,809,043	\$349,045,216	\$ 698,090,431
Ameren	69,029,540	\$345,147,698	\$690,295,396
Dominion	62,071,888	\$310,359,438	\$620,718,875
Edison International	61,810,500	\$309,052,499	\$618,104,997
Progress Energy	58,930,512	\$294,652,560	\$589,305,121
TXU	54,946,087	\$274,730,437	\$549,460,875
Totals	906,385,120	\$4,531,925,602	\$9,063,851,203

Source: Ceres, Natural Resource Defense Council, and Public Service Enterprise Group, *Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States – 2004,* (April 2006) (available at: http://www.nrdc.org/air/pollution/benchmarking/2004/benchmark2004.pdf and http://www.nrdc.org/air/pollution/benchmarking/default.asp).

Thus, over the first ten years of the program, the value of the allowances AEP would receive would range from \$8.2 billion to \$16 billion dollars – ten times the value of the SO_2 allowances it received during the first ten years of the Acid Rain Program.

Conclusion - A Different Approach

There is growing recognition that giving CO_2 allowances away for free leads to windfall profits for companies. As mentioned above, in contrast to a free allocation of CO_2 allowances, other major environmental programs are based on the *polluter pays principle* – those entities that

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16 Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions.*

17 Additional information regarding each company is provided in Appendix C.

create the pollution must pay for any required cleanup. No other environmental program, allows a company to profit from releasing the most pollution.

Auctioning emission allowances could raise sizable revenues that lawmakers could use for various purposes, some of which could lower the cap's overall cost to the economy. For example, policymakers could require that proceeds from an auction be used to decrease the budget deficit, which would strengthen the economy. Proceeds could also be used to reduce taxes on labor, capital, or personal income that could be affected by a CO_2 cap.[18] Depending on the stringency of the cap and the type of tax cut, such an approach could reduce the economy wide cost by roughly 50 percent, or perhaps substantially more, some researchers suggest.[19] Revenues can also be used to achieve other aims such as research, development, and deployment of new low carbon technologies, which could help reduce the growth of CO_2 emissions and increase energy efficiency, or could support adaptation and transitional programs to help workers and low-income households transition into a carbon constrained economy.

Another option being debated as a means to avoid the potential windfalls is allocating allowances to state regulated electric distribution companies (and providing explicit guidance to state regulators about the proper treatment of those allowances), rather than allocating directly to electricity generators.[20] This method would cause all electric sector allocations to "come under the purview of economic regulators—state public utility commissions in the case of investor-owned utilities and local boards in the case of publicly owned utilities and cooperatives."[21] Distribution companies would sell the allowances they are allocated to regulated sources (e.g., power plants), and return the revenues to their customers. Advocates for this alternative explain that "these authorities are in the best position to sort out the equity implications of different allocation schemes, direct appropriate levels of compensation to adversely affected firms, and ensure that end-use customers, who bear the largest share of program costs, receive an equitable share of the asset value associated with free allowances."[22]

Regardless of how the revenues are allocated, any CO_2 cap-and-trade program should not perpetuate the system of effectively allowing the most polluting companies to significantly profit from the pollution they have generated. Other significant environmental statutes are based on the equitable principle that the polluter should pay for any cleanup for which it is responsible. Any climate change legislation should be no different. A CO_2 cap-and-trade program can create benefits for society. A CO_2 program must not create windfall profits for the polluting companies, and distributing allowances free of cost to industry would only ensure such an inequitable result.

[18] Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions.*
[19] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System.*
[20] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System.*
[21] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System.*
[22] National Commission on Energy Policy, *Allocating Allowances in a Greenhouse Gas Trading System.*

Appendix A – Top Ten CO_2 Emitting Electric Utilities in the U.S.

Top Ten CO_2 Emitting Electricity Sector Companies in the U.S. (2004 data)

Company	Total (MWh)	NO_x (tons)	SO_2 (tons)	CO_2 (tons)	Hg (lbs)
AEP	190,358,346	318,783	963,838	163,934,554	7,498
Southern	186,294,694	216,824	886,735	148,647,755	7,821
Duke	168,010,605	190,722	873,574	113,602,312	3,973
Tennessee Valley Authority	157,556,843	199,801	492,605	103,602,929	3,360
Xcel	81,283,493	124,237	157,324	69,809,043	2,183
Ameren	74,954,742	67,553	318,461	69,029,540	2,943
Dominion	105,971,331	107,670	225,452	62,071,888	2,062
Edison International	78,170,023	93,760	271,764	61,810,500	2,837
Progress Energy	93,252,779	105,052	351,276	58,930,512	1,907
TXU	67,922,206	43,812	241,010	54,946,087	4,607
TOTALS	1,203,775,062	1,468,214	4,782,039	906,385,120	39,191
ELECTRIC SECTOR TOTAL	3,810,555,000	4,143,000	10,309,000	2,456,934,000	96,000
PERCENTAGE SHARE	32%	35%	46%	37%	41%

Source: Ceres, Natural Resource Defense Council, and Public Service Enterprise Group, *Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States – 2004,* (April 2006) (available at: http://www.nrdc.org/air/pollution/benchmarking/2004/benchmark2004.pdf and http://www.nrdc.org/air/pollution/benchmarking/default.asp#).

Appendix B- AEP SO_2 Allowance Analysis

This write up provides the initial SO_2 allowance allocations and their financial value for American Electric Power Company (AEP).

Methodology

Step 1 – Identification of AEP Electric Generating Facilities

The 2006 Benchmarking Report (2004 data year) electric generation facility ownership breakdown was utilized to identify AEP wholly and jointly owned electric generating facilities.

Step 2 – Query the EPA Data and Maps Query Tool[23]

Using the list of AEP facilities obtained from the Benchmarking Report, EPA's Allowance Query Wizard was used to determine the facility allocations for Phase 1 (1995-1999); Phase 2a (2000-2009) and Phase 2b (2010- and beyond).

Step 3 – Utilize Average SO2 Allowance Values to Calculate Allowance Value

Using EPA data for historical average SO2 allowance prices (1995-2004) and broker reported values for 2005, the financial value of the allowances allocated to AEP were then estimated.

[23] See http://cfpub.epa.gov/gdm/index.cfm?fuseaction=iss.isshome.

Appendix C – Corporate Information Regarding the Top Ten CO_2 Emitting Electricity Sector Companies in the U.S.

1. AEP

AEP owns and operates about 80 generating stations in the United States, with a capacity of more than 36,000 megawatts. AEP's utility units operate as AEP Ohio, AEP Texas, Appalachian Power (in Virginia, West Virginia), AEP Appalachian Power (in Tennessee), Indiana Michigan Power, Kentucky Power, Public Service Company of Oklahoma, and Southwestern Electric Power Company (in Arkansas, Louisiana and east Texas). AEP's headquarters are in Columbus, Ohio.

2. Southern

Southern owns and operates four electric utilities, with a generating capacity of more than 41,000 megawatts. Southern operates Alabama Power, Georgia Power, Gulf Power, and Mississippi Power. Other major subsidiaries and business units include Southern Nuclear.

3. Duke

Duke has a generating capacity of 37,000 megawatts and owns and operates regulated (franchised) and unregulated (wholesale) power plants in North America (North Carolina, South Carolina, Ohio, Indiana and Kentucky) and Latin America. Duke Energy Generation Services (formerly Cinergy Solutions) is the owner and operator of power generation solutions utilizing natural gas and various solid fuels, and currently owns and operates over 6,500 megawatts. Duke Energy's U.S. portfolio includes approximately 8,100 megawatts of wholesale electric generation primarily in the Midwest.

4. Tennessee Valley Authority

The Tennessee Valley Authority is a federal corporation and its system includes three nuclear, 11 fossil, 29 hydroelectric, six combustion-turbine, and one pumped-storage plant.

5. Xcel

Xcel has regulated operations in 8 Western and Midwestern states and its plants have a generating capacity of over 15,000 megawatts. Its principal non-regulated subsidiaries include, Eloigne Company and Quixx Corporation. Xcel's regulated operating companies include: Northern States Power Company Minnesota, Northern States Power Company Wisconsin Public Service Company of Colorado, and Southwestern Public Service Company. Its service company is Xcel Energy Services Inc.

6. Ameren

Ameren Corporation is the parent of AmerenCILCO, based in Peoria, Ill; AmerenCIPS, based in Springfield, Ill.; AmerenIP, based in Decatur, Ill.; and AmerenUE, based in St. Louis, Mo. Additional subsidiaries also include: AmerenEnergy, AmerenEnergy Resources, the holding company for non-rate-regulated generation, development, marketing and fuels services companies (AmerenEnergy Generating Company, AmerenEnergy Development, AmerenEnergy Medina Valley Cogen, LLC, AmerenEnergy Marketing and AmerenEnergy Fuels & Services), AmerenEnergy Resource Generating, and Ameren Services.

7. Dominion

Dominion's asset portfolio consists of about 26,300 megawatts of power generation. Its electric generating companies include: Dominion North Carolina Power and Dominion Virginia Power. Other subsidiaries also include: Dominion East Ohio, Dominion Hope, Dominion Peoples, Dominion Cove Point LNG, LP, Dominion Clearinghouse, Dominion Exploration and Production, Dominion Gathering-Producer Services, Dominion Generation, Dominion Greenbrier, Dominion Retail, Dominion Technical Solutions, Inc., and Dominion Transmission.

8. Edison International

Edison International operates in regulated and non-regulated markets with a power generation portfolio of approximately 14,000 megawatts. Headquartered in Rosemead, California, Edison International is the parent company of a regulated electric utility, Southern California Edison (SCE) and Edison Mission Energy (EME).

9. Progress Energy

Progress Energy, headquartered in Raleigh, N.C., has more than 23,000 megawatts of generation capacity. Its subsidiaries include Progress Fuels Corporation and Progress Energy Ventures.

10. TXU

TXU Corp. manages a portfolio of energy businesses primarily in Texas. TXU Power has over 18,300 MW of generation in Texas and TXU's other businesses include TXU Energy, TXU Wholesale, and Oncor Electric Delivery.